

**AN ANALYSIS REGARDING ENERGY EFFICIENCY
IN METRO ATLANTA'S PRIVATE OFFICE BUILDINGS**

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The Academic Faculty

by

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LIST OF ABBREVIATIONS

| | |
|-----------------|--|
| ASHRAE | American Society of Heating, Refrigerating, and Air-Conditioning Engineers |
| BOMA | Building Owners and Managers Association |
| CBECS | Commercial Buildings Energy Consumption Survey |
| CO ₂ | Carbon Dioxide |
| EBOM | Existing Buildings: Operations and Maintenance |
| EIA | Energy Information Administration |
| ESCO | Energy Service Company |
| EPA | Environmental Protection Agency |
| GEFA | Georgia Environmental Facilities Authority |
| IECC | International Energy Conservation Code |
| lbs | Pounds |
| kWh | kilo-Watt hour |
| LEED | Leadership in Energy and Environmental Design |
| mWh | mega-Watt hour |
| SEP | Statement of Energy Performance |
| U.S. | United States |
| USGBC | United States Green Building Council |
| NAIOP | National Association of Industrial and Office Properties |

SUMMARY

Commercial office building occupants are a significant consumer of electricity, and they subsequently contribute a significant amount of greenhouse gases into the environment in the process. As it becomes increasingly apparent that this represents a problem relative to our scarce natural resources, environment, and corporate pocketbooks, Americans are realizing that energy efficiency in buildings must be increased. While this is more easily accomplished during the design phase of a newly constructed building, the significantly larger opportunity exists to retrofit the considerable stock of this country's existing office buildings.

The Energy Star certification represents an independent verification of a building's superior energy efficiency, yet only 16% of metro Atlanta's office space has achieved it. The intent of the research was to identify the current state of energy efficiency in buildings, and to identify potential obstacles to obtaining the Energy Star certification. Towards this goal, secondary research was conducted among prominent academic journals, as well as numerous professional and governmental organizations and publications. Primary research was conducted through an online survey of Facility Managers, Property Managers, and Building Engineers of Energy Star office buildings and comparable non-Energy Star office buildings in the metro Atlanta area. The survey was conducted mostly using closed-ended questions using a Likert scale so as to provide a basis for statistical analysis among responses, and open-ended questions were also included to identify the current state of energy efficiency practices.

The research resulted in the identification of three areas which hold statistically significant differences between Energy Star and directly comparable buildings. First, Energy Star buildings have a higher building rating on Energy Star's Portfolio Manager's scale. Secondly, Energy Star buildings have budgets which can accommodate the Energy Star certification process and any building upgrades necessary to achieve the certification. Third, Energy Star building representatives have more knowledge regarding the Energy Star certification process when compared to the representatives of comparable non-Energy Star buildings.

An analysis was also conducted regarding the age and size of all buildings surveyed, to determine if these factors influenced the building representatives' responses. Building age does seem to play a role, although further investigation is warranted to more clearly discern how building age influences the building representatives' responses. Based on responses given, it appears that building size does not influence responses.

Specifically for Energy Star buildings, four conclusions were found. First, Energy Star buildings are also pursuing LEED certification. Secondly, Energy Star building representatives believe in voluntary energy reduction and greenhouse gas reduction measures. Third, these building representatives plan to recertify the building and certify other buildings in their portfolio. Finally, Energy Star buildings were able to achieve the certification despite having to make other improvements to bring the building up to the current building code.

The research also identified five conclusions regarding the expected result when pursuing the Energy Star certification. These conclusions include the best method to achieve the Energy Star certification, the expected energy savings, the expected time

spent to achieve the certification, the expected cost to achieve the certification, and the main reasons to recertify the building.

Finally, this research highlights innovative practices in other states and cities, such as financial incentives and legislation which require commercial buildings to obtain a building rating. Such innovative practices are currently not employed in the Atlanta metro area, but would be beneficial to both the Atlanta area and to individual buildings.

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Energy consumption and Greenhouse Gas Emissions in Commercial Buildings

Business owners and operators must make decisions which will allow their businesses to thrive, and office building owners and managers are no exception. An office building can be considered a strategic asset for a business, and therefore it must be operated as efficiently as possible so as to maximize its value and utility. Building owners and managers must consider the total setting in which a building exists, including economic, environmental, and social factors.

One consideration is the building's systems' level of energy efficiency, which has the ability to affect three types of above-listed factors. At a high level, a building's level of energy efficiency can have economic impacts (the price of energy consumed by the building's users), environmental impacts (the greenhouse gases emitted by this energy consumption), and social impacts (the public perception regarding the owner's energy management practices). In fact, energy efficiency is emerging as a strategic initiative for building owners and managers, as energy prices rise and the effects of global warming become more prominent.

While social factors are more difficult to quantify, the economic and environmental impacts of buildings are more readily available. Buildings' users consume a significant amount of energy resources. The United States Department of Energy estimates that the United States consumed approximately 3,876.3 billion kilowatt-hours of electricity in 2008 (Energy Information Administration, "Short Term" 2009, p18).

Furthermore, the U.S. Department of Energy estimates that users of the commercial building sector consumed 36% of all electricity produced in 2006 (U.S. Department of Energy, “2008 Buildings”, 2008, p.1-1). Assuming that the commercial building sector continues to represent 36% of the US’s electricity, this translates into approximately 1,395.47 billion kilowatt-hours of electricity consumed in 2008.

As a result of this consumed energy, the building sector also represents a significant contribution to greenhouse gas emissions, including carbon dioxide. The creation of energy causes greenhouse gases to be released into the atmosphere; thus the more energy consumed, the more greenhouse gases emitted. While the actual level of carbon dioxide emissions varies by region based on a variety of factors, the table in Appendix 1 illustrates that an average of 1,318.22 pounds of carbon dioxide emissions are generated for every megawatt hour of electricity consumed in the United States, as measured by a straight-line average across all regions (U.S. Environmental Protection Agency, 2008). This rate suggests that approximately 919,766,913 tons of carbon dioxide were generated by energy consumption in the United States’ commercial building sector in 2008, as shown below in Table 1.

Table 1: Estimated Annual CO2 Emissions from U.S. Commercial Buildings

Source: EPA's Emissions & Generation Resource Integrated Database

| | | Measurement | Source |
|---|--------------------|-------------|-----------------------------------|
| US Electricity Consumed Annually | 3,876,300,000 | mWh | Energy Information Administration |
| Percent in Commercial Building Sector | 36% | | US Department of Energy |
| US Commercial Building Sector Electricity Consumed | 1,395,468,000 | mWh | Calculation |
| Average CO2 emission rate | 1318.22 | lb / mWh | eGRID straight-line average |
| US CO2 emissions in Commercial Building Sector | 1,839,533,826,960 | lbs | Calculation |
| US CO2 emissions in Commercial Building Sector | 919,766,913 | tons | Calculation |

To be more specific, research has identified the specific portions within the U.S. commercial building sectors consume the most energy (Perez-Lombard, Ortiz, & Pout, 2008, p. 397). Table 2 shows that users in office buildings represent the second largest consumer of energy (18%) within the commercial building sector, thus it is worthwhile to target offices as a place to make a significant impact through energy conservation. Furthermore, the annual consumption and emissions rate of the U.S. office sector can be estimated, as noted below in Table 3.

**Table 2: Energy Use in the
Commercial Sector by Building Type**
Source: Perez-Lombard, Ortiz, & Pout

| <u>Building Type</u> | <u>%</u> |
|------------------------|------------|
| Retail | 32% |
| Offices | 18% |
| Hotels and Restaurants | 14% |
| Schools | 13% |
| Hospitals | 9% |
| Leisure | 6% |
| Other | 9% |

**Table 3: Estimated Energy Consumption and Greenhouse Gas Emissions in the U.S.
Office Sector**
Source: Perez-Lombard, Ortiz, & Pout

| | Annual Energy Consumed (mWh) | Annual CO2 Emissions (tons) |
|----------------------------|------------------------------|-----------------------------|
| Commercial Building Sector | 1,395,468,000 | 919,766,913 |
| Office Sector | 18% | 18% |
| Office Sector | 251,184,240 | 165,558,044 |

While these figures are estimations, it is evident that users of office buildings are responsible for a significant portion of energy consumption and greenhouse gas emissions. It is becoming increasingly understood that our pool of current energy sources have a finite supply and greenhouse gases emitted are increasingly contributing to the undesired effects of global warming. Currently a significant amount of discussion is currently taking place regarding policies to reducing the negative effects of these

contributions. As stewards of the planet, it is wise for us to collectively make smart choices about how we use energy, so that we can conserve the pool of existing energy sources, and minimize the emission of greenhouse gases into the atmosphere.

1.2 Opportunity to Improve the Private Sector’s Existing Buildings

The United States contains nearly 65 billion square feet of existing office space (Energy Information Administration, “Occupancy”, 2006). A recent study shows that this amount dwarfs the amount of annual newly-constructed office space. In 2004, The Brookings Institute provided a forecast for commercial and institutional buildings in the United States between 2000 and 2030, which called for over 213 billion square feet of new and replaced commercial and institutional space by 2030 (Nelson, 2004, p.7). While a number of factors will affect (and already have affected) the forecast, it is a reasonable figure given its 30 year time span. If the total square footage required is annualized over the years between 2000 and 2030, on average there will be more than 3.8 billion square feet of commercial and institutional space constructed each year.

Table 4: Commercial Square Feet Demand by 2030

Source: Nelson, A. “Towards a New Metropolis”

| Geographic Area | Estimated Square Feet in 2000 (000s) | Square Feet Needed 2030 (000s) | New & Replaced Square Feet (000s) |
|--------------------------------|--------------------------------------|--------------------------------|-----------------------------------|
| United States | 295,874,358 | 427,250,696 | 213,449,209 |
| Annual Rate 2000 - 2030 | | | 7,114,973 |

Certainly that is a significant amount, and we are wise to design this space with energy efficient measures from its conception, when it is easiest and more cost effective to do so. As earlier mentioned, many green building initiatives are underway to affect this 7.1 billion square feet of newly constructed commercial space. However, when compared to the nearly 65 billion square feet of currently existing office space in this country, it is clearly impossible to effectively address energy conservation and greenhouse gas emissions without addressing the vast stock of existing buildings as well.

Within in the existing stock of office space, the largest opportunity to implement energy efficiency resides with privately-owned buildings, since this stock is significantly larger than that of government-owned buildings. The CBECS calculated the total floor space for both private and government-owned commercial office buildings, as shown below in Table 5 (Energy Information Administration, “Occupancy”, 2006). As of 2003, there was more than three times as much privately-owned floor space as compared to government-owned floor space. While governments continue to strive to implement green building measures, it can be concluded that the private sector offers a significantly larger opportunity for both energy and greenhouse gas emission savings. However, the private sector is more complicated to regulate, given the proliferation of landlords among that 49 billion square feet of real estate.

Table 5: Total Square Feet of Commercial Office Space
Source: Energy Information Administration

| | Privately Owned | Government Owned | Total |
|---------------|-----------------|------------------|----------------|
| All Buildings | 49,421,000,000 | 15,363,000,000 | 64,784,000,000 |

1.3 Typical Commercial Building Construction and Energy Efficiency

To understand energy efficiency in buildings, it first must be understood how they are constructed. Buildings are constructed according to the state building codes in the area, which are often more stringent than the federal building code. The energy efficiency portion of the state building codes is based on the International Energy Conservation Code (IECC), which in turn references a standard published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, known as ASHRAE (American Society, n.d.). ASHRAE's 90.1 standard establishes a set of voluntary standards related to minimum energy efficiency in buildings. This 90.1 standard was created in 1975, and has been updated several times to incorporate more rigorous and comprehensive energy efficiency measures. Each version of the standard is denoted by the year in which it was adopted, such as 90.1-1989, 90.1-1999, 90.1-2001, 90.1-2004, and 90.1-2007. New commercial buildings in Georgia must currently be built to the 90.1-2006 version of the standard; compliance is checked with the Department of Energy's ComCheck software. (U.S. Department of Energy, "Georgia," n.d.).

While the exact level of energy efficiency for each building is difficult to determine without a specific test for each building, it is most reasonable to assume that each commercial office building was built up to the level of the existing building code during the time of construction. While it is possible that developers built structures which exceeded the current building code, it is somewhat unlikely since most developers sell the building to another owner at the completion of construction, thus may not have proper incentive to include extra energy efficiency measures (S. Hammerling, personal communication, March 16, 2009).

The Department of Energy has recently issued a report which demonstrates the increasing level of energy efficiency achieved in buildings as the ASHRAE 90.1 standard becomes more stringent over time. The study relates that buildings constructed to the 90.1-2004 version of the standard conserved 13.9% more energy than buildings built to the 90.1-1999 version of the standard (U. S. Department of Energy, “Building,” 2008).

However, since building and energy codes have been updated and upgraded over time, older buildings did not necessarily need to achieve the current level of energy efficiency currently as required by current code for new construction. Depending on its unique characteristics, each existing office building has a different level of energy efficiency based on the code requirements of the time, and it is very likely that some of today’s existing buildings have significant room for improvement. A recent report from the National Association of Energy Services Companies indicates that “at least 30% of the energy used in commercial buildings is wasted,” (ICF International, 2008, p.4) which confirms the magnitude of which energy efficient retrofits may help to improve the existing built environment.

1.4 Current State of Energy Efficiency Initiatives

Despite the cited need to improve energy efficiency in existing buildings, much attention is focused on improving energy efficiency in new buildings, perhaps because it is easier and more cost effective to implement energy efficiency during the building’s design phase rather than when the building already exists. However, as noted by the discrepancy in size between the existing and new building sectors, efforts towards increasing energy efficiency in the existing building sector have the potential to make a

much larger impact, and must be considered as well. The following outlines the current state of existing initiatives aimed at improving the energy efficiency in both new and existing buildings. The initiatives include building certification programs, legislation, and voluntary energy efficiency programs.

1.4.1 Building Certification Programs

There are two prominent certification programs that a building in the United States can pursue which relate to energy efficiency. Given the importance of energy costs in a competitive office marketplace, a building's owner (or prospective owner) can find it beneficial to understand the building's level of energy efficiency. While an owner can make claims regarding the energy efficiency of a building, it is more powerful to obtain a third-party certification based on the actual measurement of a building's efficiency.

The first certification program is Energy Star, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. This program was created in 1992 as a voluntary labeling program designed to promote energy-efficient computers, and subsequently has evolved into a comprehensive program aimed to encourage energy efficiency for the commercial, residential, and industrial building sectors, as well as building materials, appliances, and electronics. Energy Star defines an "office" as a 5,000+ square foot building, which operates between 30 and 168 hours per week, which has at least one personal computer and at least one worker on the main shift (Energy Star, n.d.).

Any building owner or manager can evaluate a building's performance with the Energy Star's free "Portfolio Manager" software (Energy Star, n.d.). This software uses

the building's specifics including size, type, and energy consumption to calculate the building's rating on a scale of 1 to 100, which demonstrates its level of energy efficiency. This building rating can be compared against the national CBECS database of comparable properties, and any building which achieves a rating of 75 or better (indicating that it performs better than 75% of comparable properties) is eligible to achieve the Energy Star certification (Energy Star, n.d.). The software is available for free on Energy Star's website, and requires a minimal time commitment to use.

The second certification program is the Leadership in Energy and Environmental Design program (LEED), as administered through the United States Green Building Council (USGBC). LEED is also a voluntary third-party certification program designed to promote overall sustainability in the built environment. This credit-based program allocates credits to various sustainable characteristics of a building, and provides certain levels of certification based on the number of credits achieved. LEED programs exist for a variety of building types, including:

- LEED for New Construction (LEED-NC);
- LEED for Existing Buildings Operations and Maintenance (LEED-EBOM);
- LEED for Homes;
- LEED for Commercial Interiors (LEED-CI);
- LEED for Core and Shell (LEED-CS);
- LEED for Schools;
- LEED for Healthcare; and
- LEED for Retail

(United States, n.d.).

An office building pursuing LEED may fall under LEED-NC, LEED-CS, LEED-CI, or LEED-EBOM, depending the building's age and type of construction.

All of these LEED programs offer the categories of credits listed below (United States, n.d.).

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation

The Energy & Atmosphere section of credits measures the building's level of energy efficiency, and it uses the Energy Star's building rating system to determine the number of LEED credits for which the building is eligible. The E&A section accounts for a substantial portion of the total available LEED credits, thus indicating the ability of an energy-efficient building to perform well to LEED standards (United States, n.d.). Thus, it follows that obtaining an Energy Star certification can assist a building to also obtain credits for the appropriate LEED certification program. While a building must meet the prerequisites for each section of credits, the building representative can choose which credits to pursue. Once the building attains the energy efficiency requirement (which is a rating of 71 on the Energy Star's Portfolio Manager tool, which will be discussed later), the building does not necessarily need to achieve any further E&A credits in order to achieve LEED certification. Therefore, a building which obtains LEED certification does not truly indicate its level of energy efficiency. Furthermore, the

LEED certification process is somewhat time-intensive since it requires documentation for all credits sought, and it requires the building representative to pay registration and certification fees. The LEED certification is a measure of overall sustainability in the built environment, where energy efficiency plays a variable role in its certification level.

1.4.2 Legislation

Despite the lack of a consistent standard on energy efficiency in commercial office buildings, governments are attempting to lead by example by making substantial efforts to establish green building policies for their agencies and government buildings. This legislation is enforceable since governments have the power to regulate the conditions of their own facilities, whereas they currently do not have the ability to regulate the private sector.

Many governments are beginning to enact legislation regarding energy efficiency in new buildings. LEED certification is beginning to emerge as the sustainability standard, and the federal government (as well as many state and local governments) have enacted legislation in the past few years that calls for newly constructed government buildings to be built to LEED standards.

However, initiatives regarding existing buildings are less rigorous. At the city level, signatories to the U.S. Mayor's Climate Protection Agreement have passed a variety of forms of legislation requiring green standards for construction and substantial renovations of existing buildings (Sentman, Del Percio, & Koerner, 2008, p. 49). Atlanta is one of the signatories to this Agreement. The signatories have volunteered to "make energy efficiency a priority through building code improvements, retrofitting city facilities with energy efficient lighting and urging employees to conserve energy and save

money; and to purchase only Energy Star equipment and appliances for City use” (The U.S. Conference of Mayors, 2005). The City of Atlanta’s Office of Sustainability also recently launched a number of sustainability initiatives aimed at city-owned buildings. Those which relate to existing buildings include “mandating lighting sensors, improving the maintenance system, installing automatic sensory faucets and setting citywide policies on temperature settings,” and for major building renovations to be completed to LEED-Silver certification levels (City of Atlanta, n.d.). Both of these initiatives in the Atlanta area are good steps, however, there appears to be no measurable standard regarding the degree to which these energy efficiency efforts are implemented.

With specific regard to the Energy Star program, it is notable that nine other state and local governments in the United States have created legislation related to pursuing Energy Star certification. The published list, current as of July 2008, is located in Appendix 2, and notably, local and state governments in Georgia are absent from this list (Energy Star, “State and Local,” 2008).

In conclusion, legislation regarding energy efficiency is largely targeted towards newly constructed government buildings. The fewer measures which address energy efficiency in existing buildings do not appear to have a comparable, measurable standard by which to judge their performance.

1.4.3 Voluntary Initiatives

The final set of initiatives includes voluntary measures created by various organizations. The first voluntary initiative is the Energy Star Challenge, a national call to action to improve energy efficiency in buildings by 10% (Energy Star, “Energy Star Snapshot,” 2008). As of Fall 2008, over 1,500 organizations and individuals in the

United States have voluntarily joined the Energy Star Challenge, as well as thirty-seven state governments (including the State of Georgia), 274 local governments, and 98 real estate entities. The effects of the Energy Star Challenge can likely be seen as an increasing amount of Energy Star rated floor space over the past seven years. The Energy Star Fall 2008 report notes that close to 70% of this space is being rated repeatedly, while 30% of space is being certified for the first time (Energy Star, “Energy Star Snapshot,” 2008). As shown below in Figure 1, it can be concluded that total building space rated averaged approximately 3 billion square feet over the past 5 years, while at the same time there is a noted trend of increasing amount of repeated floor space ratings. This seems to indicate that companies find value in repeatedly rating their building space. Also, the mid-year 2008 figures for both categories already surpass the entire year’s data for 2007; if the data for the remainder of 2008 follows suit, it appears that Energy Star building ratings may be reaching a critical mass of exponential growth.

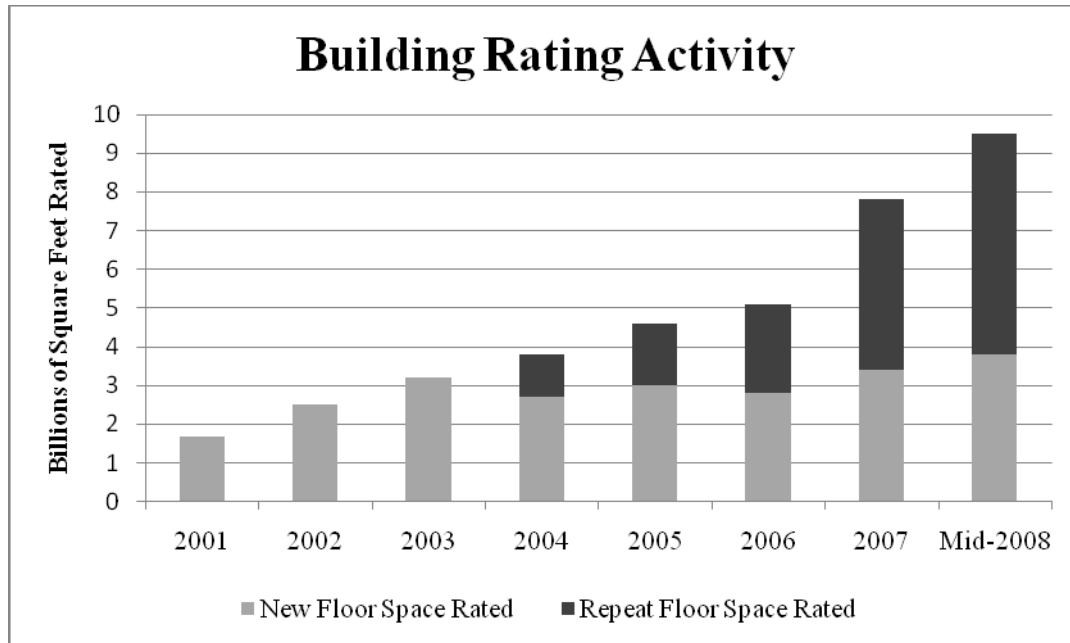


Figure 1: Energy Star Building Rating Activity
Source: Energy Star

While the State of Georgia has joined the Energy Star Challenge, there is little evidence that the Energy Star program is being supported on the local level in the metro Atlanta area. According to Energy Star, the City of Conyers is the only local government in Georgia to have joined the Challenge as of January 2009. This is notable, since many local governments in other states have joined the challenge, in addition to their State Governments joining. Thus, these other states seem to signify the ability/need for energy efficiency at the local level, yet local governments in the Atlanta metro area have largely not yet accepted the Energy Star Challenge, which may indicate that Georgia buildings are not among those making substantial contributions towards the recent notable gains in building ratings. While private commercial buildings are not regulated by local governments, the level of governmental participation in the Energy Star Challenge may provide insight into the overall acceptance of the Energy Star program itself.

Secondly, Governor Purdue launched the Governor's Energy Challenge in April 2008, to be administered through the Georgia Environmental Facilities Authority, or GEFA. The Challenge includes a commitment that Georgia's state government will reduce energy consumption by 15% by 2020 (relative to 2007 levels) through a combination of energy efficiency and renewable energy methods. Governor Purdue subsequently challenged private offices, among other entities, to meet this goal as well. While GEFA is not at liberty to disclose the list of the participants in the Governor's Energy Challenge, state buildings must meet this challenge (State of Georgia, 2008).

Third, the Building Owner and Managers Association (BOMA), a prominent professional network, has issued the BOMA 7-Point Challenge, which is aimed towards reducing energy consumption in commercial buildings by 30% by 2012, as shown in Appendix 3. At the time this project's research was initiated, Appendix 4 demonstrates that BOMA-Atlanta was not yet one of the participants in this voluntary program, while 51 other cities, metro areas, and states had taken this challenge. Yet, during the research process, BOMA-Atlanta did become one of the BOMA chapters to support its 7-Point Challenge. Because BOMA is such a prominent network for commercial office professionals in Atlanta, this commitment will likely prove to be a positive factor in the City's pursuance of energy efficient measures.

Given the three voluntary "challenges" issued by governments and professional associations, it is probable that a certain percentage of private office building owners see value in pursuing energy efficient measures beyond the existing building codes, and these building representatives will likely find financial incentives to be helpful, if not required. Increasing energy efficiency will likely require at least some capital investment, and

building representatives may or may not have these funds available in addition to their ongoing operational budgets. The building representatives who do not have the available funds may simply not be able to incorporate energy efficiency measures, even if a company believes it could benefit from increased energy efficiency.

Accordingly, the Georgia Department of Revenue has established the Clean Energy Tax Credit, which provides tax credits to corporations for renewable energy equipment and certain energy efficient equipment. The credit is available between May 2008 and December 2012, and is worth up to \$2,000,000 annually (U.S. Department of Energy, “Database,” n.d.). GEFA performs the approval process for these tax credit applications. In an interview with GEFA in January 2009, it estimated that at that time approximately \$1,000,000 of tax credits had been applied for, and further confirmed that \$491,874.00 of tax credits had been approved between May 2008 and January 9, 2009 (T. Williams, personal communication, January 9, 2009). While this demonstrates that corporations are applying for these available tax credits, the program was somewhat underutilized in 2008, perhaps due to the time required to install energy efficient measures, the newness of the program, or other reasons. The value of these incentives will be able to be more fully understood in future years, as it will become evident if corporations apply for the full \$2,000,000 credit value.

In conclusion, there are various voluntary programs that seek to increase the energy efficiency in existing buildings, although their participation levels in Georgia could be improved. The fact that voluntary programs exist seems to suggest that some building representatives understand that the existing building codes and legislations are not enough, and they are taking their own voluntary measures to improve their buildings.

1.5 Energy Efficiency Benefits for Private Owners

Implementing energy efficient measures represents a significant opportunity for the private sector, since energy's impact on real estate is expected to continue to grow. Jones Lang LaSalle's recent publication on energy strategies summarizes the global problem faced by the corporate real estate sector. "Finite (energy) supplies, growing global demand and constant volatility will continue to put upward pressure on energy prices for the foreseeable future. It is clear that the increasing dependence on oil and rising energy prices pose a significant threat to commercial real estate operations and corporate profits." However, Jones Lang LaSalle also completed a recent survey of corporate executives, which found that "only 15 percent of respondents had a strategy to deal with rising energy expenditures" (Probst & Schinter, 2006, p.2).

Charles Lockwood, a noted green building expert, further reports that as new green buildings are built, existing buildings will need to catch up in order to remain competitive. "A significant real-estate market shift is gathering momentum: Green buildings—which have a less negative impact on the environment, boast lower energy consumption, and offer healthier indoor environments than "standard" buildings—are going mainstream". Lockwood further cites that "trillions of dollars of commercial property owned by real-estate investment trusts, corporations and other investors around the world will soon become obsolete—and will drop in value," if these properties do not undergo retrofits to make themselves green as well (Lockwood, "As Green," 2006, p.1).

Lockwood confirms this trend by providing further analysis. "Whether a company owns or leases its workplaces, this looming obsolescence of conventional real estate will impact its competitiveness and bottom line, because it will have higher

operating costs, weaker productivity rates, greater absenteeism, and less-than-stellar Corporate Social Responsibility reports compared to its peers” (Lockwood, “Green,” 2008, p. 17).

Given the large size of the existing stock of office buildings as discussed earlier, it can be concluded that energy efficiency efforts in office buildings can result in positive economic impacts for these buildings’ owners as well as positive environmental impacts. The Illinois Smart Energy Design Assistance Center (SEDAC) provides one example of the positive financial impact that energy efficiency can make for the buildings’ owner. SEDAC provides energy audits and feasibility studies for 20 small businesses in Illinois, towards a goal of implementing energy efficient building redesign strategies and energy cost reduction measures. The resulting energy consumptions of the buildings are then compared to the Energy Star rating scale. As of June 30, 2007, SEDAC had worked with 877 Illinois businesses, representing 10 million square feet of real estate. The analysis suggests that “with a one-time investment of \$23.3 million, these businesses could accrue annual energy cost savings of over \$5.7 million. For a project life of 20 years, this translates into a 28.5 percent return on investments made.” Furthermore, the energy cost reduction measures recommended “could help the participating Illinois small business owners reduce their monthly operational expenditures by \$478,199. The \$5.7 million in projected energy cost savings... may then be used to help these small businesses expand operations and create job opportunities – improving their ability to compete in the global marketplace (Fournier, & Deal, 2007, p. 56). This example makes it clear that efficient energy consumption can make a significant financial and strategic impact for a business.

Energy Star's independent status can also be used to communicate a building's benefits to interested parties. Some individual office building owners and managers have undertaken measures to make their buildings more energy efficient, but it can be difficult to effectively communicate the value of these benefits to potential buyers and tenants. The potential tenants and owner of a commercial office building need an objective way to evaluate a building's level of energy efficiency so that they can make informed decisions regarding the lease or purchase of the building, and the Energy Star building serves that purpose.

Two recent studies have quantified the benefits that the Energy Star certification provides. CoStar, a private real estate research firm, concluded that on average, Energy Star buildings achieve sales prices of \$61 per square foot more, obtain \$2.40 higher rental rates, and enjoy a 3.6% higher occupancy rate when compared to buildings considered to be their peers (Burr, "CoStar,"2008).

Furthermore, In March 2009, The Royal Institute of Chartered Surveyors, a London-based global property professional's organization, conducted an empirical analysis regarding such premiums in the United States office market. It concluded that Energy Star office buildings in the United States command 3% higher rental rates, 6% higher effective rent rates, and 16% higher sales prices than comparable buildings. Notably, the same study concludes that the Energy Star label is more desirable than the LEED label. The report states that "we find consistent and statistically significant effects in the marketplace for the Energy Star labeled buildings. We find no significant market effects associated with the LEED label. Energy Star concentrates on energy use, while the LEED label is much broader in scope. Our results suggest that tenants and investors

are willing to pay more for an energy-efficient building, but not for a building advertised as ‘sustainable’ in a broader sense” (Eichholtz, Kok, & Quigley, 2009, p.28). The expectations to achieve these types of financial results may be one reason why owners chose to pursue the Energy Star certification for their buildings.

Finally, a building’s high level of energy efficiency can also help to attract tenants, which was recently demonstrated by a study of more than 400 corporate real estate executives, conducted by CoreNet Global and Jones Lang LaSalle. The study concludes that 40% of these executives rate “energy as a ‘major factor’ in their companies’ location decisions, with an additional 36% calling it a ‘tie-breaker’ between locations that are otherwise competitive” (Facilities Management News, 2008). This research demonstrates that buildings which are more energy efficient than their peers should be able to achieve more leases (and therefore larger cash flows) than their less-efficient peers.

1.6 Estimation of Energy Star Office Space in Metro Atlanta

Given the benefits that the Energy Star certification label can provide to a building and its representatives, we can examine the level to which the metro Atlanta area office buildings have achieved the certification. The first step is to define the metro Atlanta area as it relates to office space. CoStar is a prominent firm which tracks the amount of office space in the Atlanta area, and it defines the Atlanta office market as the 29-county area as shown in Figure 2. For context, it should be noted that CoStar’s definition is a close approximation of the Atlanta Metropolitan Statistical Area, which currently encompasses 28 counties (U.S. Census Bureau, 2007).

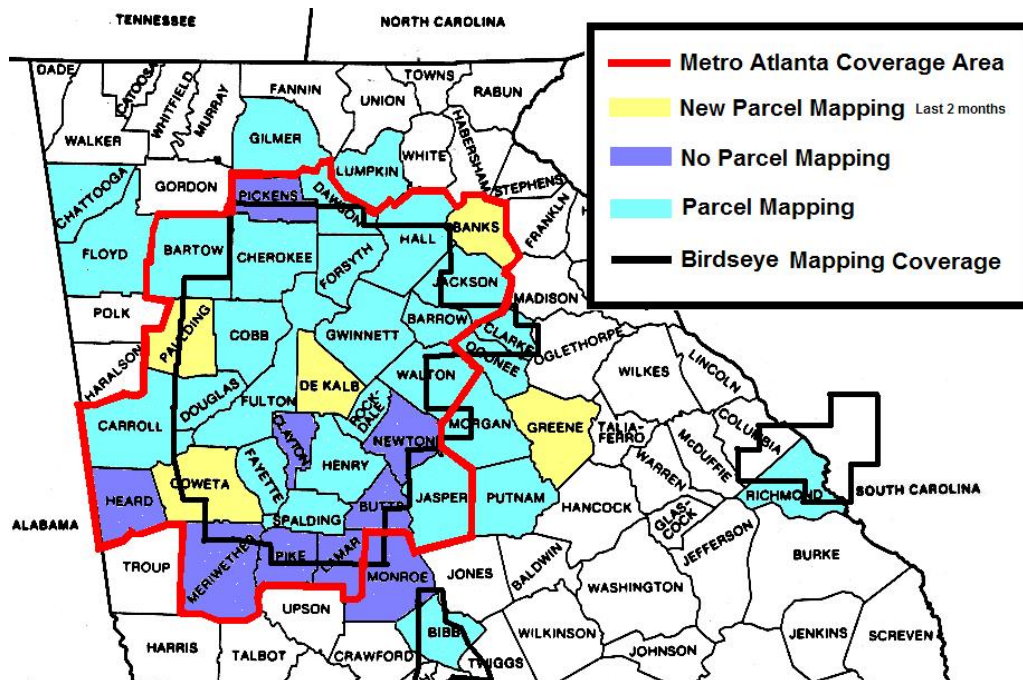


Figure 2: Definition of Atlanta Office Market

Source: www.costar.com

At the time this research was conducted, CoStar's most recent publication for 3Q2008 cited 189,006,015 square feet of office space within this defined Atlanta office market (Carter, 2008). For comparison, another prominent firm, Transwestern, cited 190,700,000 square feet in its Year-End 2008 report (Transwestern, 2008). Therefore, it is reasonable to estimate the metro Atlanta office market to contain a total of approximately 190,000,000 square feet in the Spring of 2009.

In January 2009, the Energy Star website listed a total of 70 office buildings (equating to 30,007,808 square feet of office space) in the metro Atlanta area which had obtained the Energy Star certification. Therefore, it can be concluded that approximately 16% of the office space in metro Atlanta is currently Energy Star certified.

Table 6: Estimated Energy Star Certified Office Space in Metro Atlanta

Source: Energy Star, CoStar, Transwestern.

| | Square Feet | Source |
|---|-------------|--|
| Metro Atlanta Energy Star certified office space | 31,007,808 | Energy Star |
| Estimated Total metro Atlanta office space | 190,000,000 | Estimation based on data from CoStar, Transwestern |
| Percent of metro Atlanta office space that has achieved Energy Star certification | 16.32% | Calculation |

Given the voluntary nature of Energy Star's certification program, it is evident that the owners of this 16% of metro Atlanta's Energy Star certified office space have chosen to pursue the Energy Star certification on their own volition, which indicates that these owners perceived a benefit to obtaining the Energy Star certification for their buildings. However, only 16% of office space has attained certification in the 10 years since the program began, which suggests that the Energy Star program may not be fully embraced by building owners, managers, and developers.

1.7 Research Objectives

To summarize the issues, metro Atlanta and its companies would benefit from increased energy efficiency in existing private office buildings, but obstacles may exist which prevent this increased efficiency. The Energy Star program provides an independent benchmark to which building representatives can compare their building's performance. While some states and local governments are beginning to legislate policies incorporating Energy Star, Georgia is not on this list, and its existing energy efficiency policies for existing buildings lack measurable standards to judge the

effectiveness of the programs. Building representatives must voluntarily incorporate and finance energy improvements if they believe it is valuable and feasible to do so.

Voluntary energy efficiency challenges have been issued to private office building representatives, but it appears that these challenges are not being taken on a large scale. State and Federal agencies have begun to issue tax incentives aimed to encourage energy efficient investments in the private sector, although evidence suggests that these programs were underutilized in 2008. Sixteen percent of Atlanta's office buildings have achieved the Energy Star certification, which indicates its owners find value with the program, and this value has been confirmed by various studies of Energy Star buildings. However, it also signifies that there is an opportunity for additional buildings to seek the certification as well.

The first goal of this study is to identify differences among Atlanta area office buildings and their representatives which have enabled some buildings to achieve the Energy Star certification. These differences may include corporate beliefs and values regarding the Energy Star program, or in the buildings' characteristics themselves, which might explain varying levels of interest or ability for the building to pursue the Energy Star certification. In order to understand this, primary research was conducted among two samples of buildings in the metro Atlanta area; one sample which had achieved the Energy Star certification, and the other sample which had not achieved the Energy Star certification.

The second goal is to identify the general costs, benefits, required efforts, and best methods of actually achieving the Energy Star certification. While companies may be hesitant to provide such information based on its perceived proprietary nature, it is a

worthy objective since there is a certain amount of uncertainty in the marketplace regarding the realities of becoming more energy efficient. Information from those buildings which have achieved the Energy Star certification may prove beneficial for those buildings that are also interested to pursue it as well. This information was sought with the intent to provide general knowledge about the Energy Star process, so as to improve the general performance of buildings in the metro Atlanta area.

The third and final goal of this study is to identify any other jurisdictions which have successfully implemented policies towards increasing energy efficiency in commercial buildings. To this goal, it is possible that local jurisdictions in the metro Atlanta area may be able to leverage this knowledge to incent existing buildings in our area to become more energy efficient. Again, this goal is born from the intent to learn from those who have been able to increase awareness of energy efficiency measures, as a complement to their success.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Scope of Study

The scope of this study involves two sample groups of buildings in the Atlanta office market. The intent of breaking the office buildings into these two samples was to create an ‘apples-to-apples’ comparison in order to discern differences between the samples which may help to explain varying corporate attitudes regarding the Energy Star certification process.

The first sample group consists of the office buildings which had achieved the Energy Star certification as of January 30, 2009. Energy Star’s website listed 70 such buildings, including basic information about the buildings. Of these 70 buildings, 64 were chosen for the study, as they were privately-owned Energy Star certified buildings in the Atlanta office market. These buildings range in size from approximately 95,000 to 1,200,000 square feet, and were built between 1978 and 2006. The remaining six Energy Star buildings were not included in the study since they were outliers based on the following:

- Buildings with a small or large square footage such that comparable buildings could not be identified, or
- Buildings that are owned by governments.

The second sample group was formed to include 64 buildings which had not yet achieved the Energy Star certification as of January 30, 2009. These 64 Comparable Buildings were identified by using the industry-standard practice of choosing similar

buildings based on characteristics such as the building's location, year of construction, and rentable square footage. Thus, for example, for an Energy Star building of 200,000 square feet constructed in 2000 in the Cumberland submarket, the most closely comparable non-Energy Star building was chosen. These Comparable Buildings range in size from approximately 72,000 to 1,250,000 square feet, and were built between 1980 and 2007. To show the intent of identifying similarly located samples for the Comparable group, the locations of both sample groups are shown in Appendices 5 and 6.

2.2 Building Surveys

The first part of research involved a primary study of office buildings in the metro Atlanta area, in order to better understand current corporate beliefs and values regarding energy efficiency. The process to survey these two samples began with the Georgia Tech's Institutional Review Board's successful review of the proposed survey. Then each target was called in order to introduce the study and gain permission to email a web-based survey. The intent was to reach the Property Manager or Chief Engineer for each building, as these positions tend to be most informed about a building's energy efficiency measures. Upon gaining this permission, surveys were emailed to each target, and were conducted over the course of four weeks.

The survey was designed with a limited number of questions so that it could likely be completed in approximately 5-10 minutes. It contained 18 multiple-choice or short-answer questions. In addition, the Energy Star building survey included an additional 11 questions specific to the building representatives' experience with the Energy Star certification process. Multiple-choice questions were asked in accordance with a Likert

scale (Trochim, 2006) as shown below in Figure 3, so that the two samples could be objectively compared in regards to their answers to each question. The surveys are attached as Appendices 7 and 8.

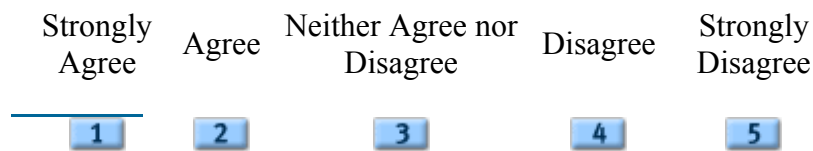


Figure 3: Likert Scale

Source: Zoomerang.com

The goal of these surveys was to receive enough responses from each sample group such that the distribution of the sample means approached the bell-shaped normal distribution for the overall population, which is the premise for the central limit theorem. To determine what the appropriate sample size is for each group, several factors were considered. The 0.95 degree of confidence was chosen, which signifies that a sample mean has a 95% chance of representing the population mean. For the Energy Star group, the minimum allowed error is 0.25. Since a lower response rate for Comparable Buildings was expected, the minimum allowed error is slightly larger at 0.50. Given these parameters, the required sample sizes for each group (Energy Star and Comparable Buildings) were determined by taking an average of the required sample size for each question (for those questions which were asked in accordance with the Likert scale rating of 1 – 5). The three survey questions which were asked according to a different scale (including the building's rating, building size, and building age) were discarded as outliers and not included in the calculation for the required sample size for each group.

Accordingly, an Energy Star sample size of 31 and a Comparable Building sample size of 11 are required, as shown in Appendix 9. Since each group contained 64 buildings, the goal of this research was to achieve a minimum of 31 Energy Star building responses and 11 Comparable Building responses, such that the premise of the central limit theorem (as earlier mentioned) would be satisfied (Mason & Lind, 1996, p.309). The respondents or their companies are not identified in this project, since anonymity was promised in order to obtain the survey responses (which some companies may perceive as sensitive corporate information).

2.3 Innovative Practices

The second part of the research identified innovative practices used by other jurisdictions across the country to promote energy efficiency programs in office buildings. The intent of this research was to provide understanding of the specific programs offered by these jurisdictions, the environments which led to the creation of these programs, and the level of success achieved. An assumption is that investigating these other existing programs may provide insights that might help to inform whether or not such programs would benefit the Atlanta metro area. Research regarding each innovative practice was conducted, and when appropriate and possible, personal interviews were conducted with the most appropriate contact within each program.

CHAPTER 3

RESEARCH RESULTS

3.1 Overview of Responses

One primary objective of the research was to identify the statistically significant differences between the samples of Energy Star buildings and Comparable buildings, although the surveys resulted in differing response levels. The survey of 64 Energy Star buildings resulted in 31 responses, which met the minimum required sample size for this group. This actually represented a response rate of 48%. These 31 responses constitute a significantly large sample size for the chosen parameters for this group, and the distribution of sample responses can be assumed to be representative of the distribution of the responses of the overall population (Mason & Lind, 1996, p.309). Thus, it can be concluded that these 31 responses are a representative sample of the overall population of Energy Star buildings in the Atlanta metro area, and therefore conclusions regarding the overall Energy Star building population can be made by using Z distribution statistical methods.

Similarly, the survey of Comparable Buildings resulted in a smaller pool of 13 respondents, which also met the required sample size for this group. The Comparable Building responses represent a 20% response rate. However, a sample size of 13 is considered a small sample size, where the distribution of sample responses may not be exactly representative of the distribution of responses in the overall population (Mason & Lind, 1996, p.400). In this case, conclusions regarding the overall Comparable Building population can be made by using *t* distribution statistical methods.

Both groups achieved the required number of sample responses given each group's chosen parameters, and the higher response rate for the Energy Star buildings is not unexpected. Building representatives whose buildings have achieved Energy Star certification generally want their achievements to be known and therefore are more willing to provide information about their efforts. Also, accurately identifying and successfully making contact with the appropriate building representative also proved to be a significant challenge during this project. For the most part, targets in both groups who were successfully contacted did complete the survey, but a small percentage did not respond because they did not feel comfortable disclosing this information. Reasonable attempts were made to obtain responses from possible respondents of this voluntary survey, but attempts were not pursued aggressively in order to maintain the professionalism of the survey.

Active data analysis was conducted between the two samples in order to more fully understand the meaning of the surveys' results. The main intention of this analysis was to identify if the two samples had statistically significant differences in the responses to each question. This analysis was conducted predominantly by using hypothesis testing of the mean response to each question. In this sense, hypothesis testing is defined as "a procedure based on sample evidence and probability theory used to determine whether the hypothesis is a reasonable statement and should not be rejected, or is unreasonable and should be rejected" (Mason & Lind, 1996, p.345). Both groups were asked the same sixteen questions so that the mean responses between both groups could be compared.

In the following list of those sixteen questions and their mean responses from both groups, the mean difference between the responses was calculated to identify the

questions whose responses have the most statistically significant difference between the groups. The goal of this research is to determine if this mean difference between the two groups' responses is statistically significant. The following hypothesis was used for each question, where μ_E represents the mean response from the Energy Star group, and μ_C represents the mean response from the Comparable Building group:

$$H_0: \mu_E = \mu_C$$

$$H_1: \mu_E \neq \mu_C$$

Thus, the null hypothesis (H_0) would be accepted if the groups' mean responses to a particular question did not have a statistically significant difference, and the null hypothesis would be rejected if the groups' mean responses to a particular question did reflect a statistically significant difference. Therefore, the research seeks to identify for which questions the null hypothesis is rejected. It is important to note that this hypothesis testing process is not testing the overall hypothesis of this thesis project itself, but rather the individual hypotheses for each of the 16 questions that there is no statistically significant difference between the sample mean responses from both groups.

Because one of the groups achieved a response rate of 13, which does not achieve the 30 responses required to use a Z test for large samples, the analysis was conducted using a t test for small samples. The two-tailed t test used a 0.05 level of significance, which is the common level of significance used for consumer research projects (Mason & Lind, 1996, p.348). The number of degrees of freedom is derived from a calculation involving the number of samples collected $(13+31-2) = 42$, and the closest measurable number of degrees of freedom is 40. Using the 0.05 level of significance and 40 degrees of freedom, an absolute value for a t statistic which is greater than 2.021 signifies that a statistically significant difference exists between the two sample groups, and therefore the

null hypothesis is rejected. The results to all questions were measured against this same benchmark so as to provide consistent measurements across all questions. As shown in the table, the survey results show that there is a statistically significant difference between the mean t responses to five of the questions (below in bold font) between the two sample groups.

Table 7: Overview of Statistical Analysis between Sample Groups

| Question | Energy Star Commercial Building Mean | Comparable Commercial Building Mean | Absolute Value of t Statistic | Reject Null Hypothesis? |
|--|--------------------------------------|-------------------------------------|---------------------------------|-------------------------|
| Comparison 11: Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software. | 82.00 | 19.31 | 8.684 | Yes |
| Comparison 7: My company's budget was sufficient to accommodate the cost of these upgrades that brought the building up to the current building code. | 2.00 | 3.75 | 7.000 | Yes |
| Comparison 3: My company is aware of the steps and costs involved to obtain an Energy Star certification for this building. | 1.39 | 2.23 | 3.266 | Yes |
| Comparison 4: In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building. | 2.00 | 2.77 | 2.438 | Yes |
| Comparison 6: In order to perform the steps to achieve Energy Star certification, this building required other upgrades to bring the building up to the current building code. | 1.74 | 1.38 | 2.334 | Yes |
| Comparison 1: Even though Energy Star is certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway. | 1.58 | 2.08 | 1.968 | No |
| Comparison 12: My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building. | 1.19 | 1.46 | 1.850 | No |
| Comparison 5: My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building. | 1.61 | 2.00 | 1.643 | No |
| Comparison 14: My company plans to continuously seek ways to improve this building's energy efficiency. | 1.39 | 1.62 | 1.386 | No |
| Comparison 10: There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program. | 2.97 | 2.62 | 1.120 | No |
| Comparison 8: This building currently performs well, and does not need energy-efficient improvements. | 2.81 | 3.15 | 0.999 | No |
| Comparison 9: My company believes a third-party certification is valuable. | 2.06 | 2.31 | 0.961 | No |
| Comparison 13: My company plans to seek Energy Star certification on other buildings. | 1.74 | 1.92 | 0.686 | No |
| Comparison 2: It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases. | 1.48 | 1.62 | 0.540 | No |
| Comparison 16: In what year was this building constructed? | 2.03 | 2.15 | 0.431 | No |
| Comparison 15: What is the total size of this building? | 3.90 | 3.77 | 0.233 | No |

3.2 Statistically Significant Differences between Energy Star and Comparable

Buildings

One major goal of this research is to identify any statistically significant differences between the two samples, and this section will discuss those results in order of those questions which achieved the highest degree of statistically significant difference.

3.2.1 Energy Star Building Rating

The most obvious difference between the two groups occurs for Comparison #11, which studies the mean building rating. The results to this question show that the Energy Star mean building rating of 82 is higher than the Comparable Building mean rating of 62. Since $\mu_E = 82$ and $\mu_C = 63$, the hypothesis testing generated a high t statistic of 8.684, indicating the two mean responses have a statistically significant difference. Clearly, this is an expected result, since the groups are identified by whether or not a building had achieved a rating of 75 or better. This self-selection makes statistical analysis between the groups a moot point, but some notable characteristics do exist. Of the Comparable Buildings, 4 of the 13 (31%) responses have used the Portfolio Manager tool to achieve a building rating. This seems significant since understanding the building's current performance is the first step to making any energy improvements and possibly achieving the Energy Star certification in the future. Because the Portfolio Manager is a free tool, cost must not be a driving factor for achieving this rating. While the survey did not specifically seek to identify reasons why 69% of Comparable Buildings have not used the free Portfolio Manager tool, possible reasons include lack of the requisite 12 months

utility data, lack of interest in improving building performance, and lack of knowledge about the Portfolio Manager tool or process.

3.2.2 Budget

The next set of conclusions involves the degree to which a building required other upgrades to bring the building up to the current building code, in order to perform the steps to achieve Energy Star certification. The t statistic of 2.334 for Comparison #6 indicates that there is a statistically significant difference between mean responses from the two samples. The Comparable Group mean was 1.38, which indicates more agreement with the question than the Energy Star mean of 1.74. This indicates that statistically, the Comparable Buildings must perform more actual improvements related to current building codes than do the Energy Star buildings, which likely can add cost, time, and/or complexity to achieving the Energy Star certification.

Responses to three survey questions serve to provide conclusions regarding the differences of the two samples' budgets to incorporate energy efficient measures. Comparison #4 examines the degree to which the building's budget has historically been sufficient to perform the steps required to obtain the Energy Star certification for this building. The t statistic of 2.438 indicates that there is a statistically significant difference between the two groups. Because the Energy Star buildings group had a lower mean response of 2.00, compared to the Comparable Building group mean response of 2.77, it can be concluded that the representatives of these Energy Star buildings agreed more with the question, and did historically have the budget necessary to take any necessary measures to achieve the Energy Star rating.

Furthermore, the budget for upgrades related to bringing the building up to current building code compliance is less available for Comparable Buildings. With a t statistic of 7.000 for Comparison #7, this is clearly a significant obstacle to overcome for the Comparable Buildings. The Energy Star group mean of 2.000 indicated stronger agreement with the question when compared to the group mean of 3.75. It can be concluded that a building which does not have the budget to perform the necessary upgrades to bring the building up to the current building code simply may not be able to proceed with achieving the Energy Star certification.

3.2.3 Knowledge of Energy Star Process

Statistically, the next most important difference between the samples deals with the building representatives' knowledge regarding the steps and costs involved to achieve the Energy Star certification. Comparison #3 demonstrates a t statistic of 3.266 for this question, which is nearly double that required to achieve statistical significance. The Energy Star group mean of 1.39 shows stronger agreement to the question when compared to the Comparable Building group mean of 2.23. While the Energy Star group should be expected to have a firm knowledge of this process since they have already gone through the process, the Comparable group shows room for increased knowledge about the process to achieve Energy Star. Of the areas which have statistically significant differences between the two groups, this is the most easily overcome, since education about the process is readily available for those who are interested. The full analysis regarding comparisons between Energy Star and Comparable Buildings is located in Appendices 10 – 25.

3.3 Insignificant Differences between Energy Star and Comparable Buildings

The remainder of the survey questions did not result in statistically significant differences between the two groups' mean responses. Those questions are outlined as follows:

Table 8: Insignificant Differences between Energy Star and Comparable Buildings

| Comparison | Question Asked |
|------------|---|
| 1 | Even though Energy Star certification is not required for this building, it is important to achieve Energy Star certification anyway. |
| 12 | My company plans to pursue the USGBC's LEED-EBOM certification for this building. |
| 5 | My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building. |
| 14 | My company plans to continuously seek ways to improve this building's energy efficiency. |
| 10 | There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program. |
| 8 | This building currently performs well, and does not need energy-efficient improvements. |
| 9 | My company believes a third-party certification is valuable. |
| 13 | My company plans to seek Energy Star certification on other buildings. |
| 2 | It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases. |
| 16 | In what year was this building constructed? |
| 15 | What is the total size of this building? |

One noteworthy point involves responses for the size and age of the buildings. As earlier outlined, the Comparable Buildings were chosen for their close approximation in building age, size, and location, so as to create the most direct building comparisons. The low t statistics of Comparisons #15 (0.233) and #16 (0.431) are the lowest of any questions asked in the surveys, and this confirms that the approach taken to identify Comparable Buildings was achieved.

3.4 Statistical Analysis among Energy Star Buildings

Since the Energy Star sample group did achieve 31 responses, this group's statistics can be considered representative of the overall population of Energy Star buildings. Therefore, statistical analysis was conducted, using Z statistics for sample sizes over 30, to identify the level of statistical significance of the responses within this sample.

Because the overall intent of the survey was to identify any possible statistically significant differences between mean responses between the Energy Star group and the Comparable group, the survey questions were worded with the hypothesis that Energy Star building representatives would tend to agree with them, while there may be some degree of disagreement from the representatives from the Comparable group. The Likert scale was used, where a "1" constituted "strongly agree," "3" constituted "neither agree nor disagree," and a "5" constituted "strongly disagree."

As such, a general hypothesis for all questions is that the Energy Star building representatives should have responses below a "3." As mean responses were calculated, this obviously was the case, as the sample means were below 3.0 for all questions. In that

case, conducting hypothesis testing for population mean for each question (μ) < 3 appeared to be a foregone conclusion, and more rigorous analysis methods were sought. Perhaps a more pertinent analysis is the possible range of the population mean μ , given the sample means, and the variance of this sample. This was calculated for sixteen of the questions, with the results shown below. For all questions, the population mean was determined using 30 degrees of freedom to the 0.05 significance level. From this analysis, there are ten questions highlighted below in bold, for which the population mean scored between 1 and 2, or between “Strongly Agree” and “Agree.” The full statistical analysis is provided in Appendices 30 – 45. In understanding with which questions respondents most strongly agree, there appear to be four prominent conclusions regarding the population of Energy Star buildings.

Table 9: Population Range for Energy Star Survey Questions

| Question # | Question | Low μ | High μ | Average μ | s^2 |
|------------|--|--------------|------------|------------------|-------|
| 12 | My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building. | 1.052 | 1.335 | 1.194 | 0.161 |
| 3 | My company is aware of the steps and costs involved to obtain an Energy Star certification for this building. | 1.191 | 1.584 | 1.387 | 0.312 |
| 14 | My company plans to continuously seek ways to improve this building's energy efficiency. | 1.213 | 1.561 | 1.387 | 0.245 |
| 2 | It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases. | 1.246 | 1.722 | 1.484 | 0.458 |
| 1 | Even though Energy Star is certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway. | 1.327 | 1.834 | 1.581 | 0.518 |

Table 9, Continued: Population Range for Energy Star Survey Questions

| Question # | Question | Low μ | High μ | Average μ | s2 |
|------------|--|-----------|------------|---------------|--------|
| 5 | My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building. | 1.396 | 1.829 | 1.613 | 0.378 |
| 15 | My company plans to continue to track this building's performance through Energy Star's Portfolio Manager software. | 1.330 | 1.896 | 1.613 | 0.645 |
| 6 | In order to perform the steps to achieve Energy Star certification, this building required other upgrades to bring the building up to the current building code. | 1.585 | 1.899 | 1.742 | 0.198 |
| 13 | My company plans to seek Energy Star certification on other buildings. | 1.485 | 1.999 | 1.742 | 0.531 |
| 16 | Since this building's original Energy Star certification, we have recertified the building on a regular basis, or plan to maintain this building's Energy Star certification in the future by going through the certification process each year. | 1.477 | 2.072 | 1.774 | 0.714 |
| 7 | My company's budget was sufficient to accommodate the cost of these upgrades that brought the building up to the current building code. | -0.539 | 4.539 | 2.000 | 13.429 |
| 4 | In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building. | 1.685 | 2.315 | 2.000 | 0.800 |
| 9 | My company believes a third-party certification is valuable. | 1.825 | 2.304 | 2.065 | 0.462 |
| 8 | This building currently performs well, and does not need energy-efficient improvements. | 2.427 | 3.186 | 2.806 | 1.161 |
| 10 | There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program. | 2.610 | 3.325 | 2.968 | 1.032 |
| 11 | Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software. | 82.476 | 86.991 | 84.733 | 39.789 |

1. The population most strongly agrees with question #12, “My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building,” as demonstrated by a population mean of 1.194. This indicates that achieving the Energy Star certification does play some role in the respondents’ desire to pursue the LEED certification as well. Notably, the population agrees with this question more strongly than Question #3 “My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.” This seems significant, since each Energy Star respondent must be aware of the Energy Star process, since they have already achieved the certification. While it’s difficult to understand the exact relationship between interest in the Energy Star and LEED certification, this analysis confirms that there is in fact a strong desire to pursue the LEED-EBOM certification.

2. The results confirmed the population’s beliefs that voluntary measures regarding continuous energy reduction and greenhouse gas emission reductions are important. Three survey questions (#14, #2, and #1), achieved the next smallest population means (1.387, 1.484, and 1.581, respectively) compared to the means for the two questions in the first conclusion. Since the Energy Star certification is a voluntary program which seeks to reduce energy consumption and greenhouse gas emissions, these responses suggest that these building representatives believe the Energy Star certification is a way to achieve these important reductions in energy consumption and greenhouse gases. In effect, the Energy Star certification works.

3. Once the Energy Star certification was achieved, building representatives observe financial and other reasons which compel them to continue tracking the building's performance, to pursue annual recertification of the building, and to pursue the Energy Star certification for other buildings. Questions #15, #5, #13, and #16 confirm agreement with these statements (with population means of 1.613, 1.613, 1.742, and 1.774, respectively), and appear to indicate the perceived value of the Energy Star certification.

4. Finally, buildings were able to achieve Energy Star certification even though the buildings required additional upgrades in order to bring the building into compliance with the current building code. The high level of agreement with Question #6 (population mean of 1.742) demonstrates that these buildings were able to overcome the potential obstacle of making building upgrades. It may be a result of the level of agreement with Question #7 (2.000), which confirmed the availability of funds to achieve those additional upgrades.

3.5 General Conclusions Regarding Energy Star Certification

Aside from statistical analysis, conclusions can also be drawn regarding common practices regarding the certification, from examining the responses from only the Energy Star group.

3.5.1 Methods Used to Achieve Energy Star Certification

Building representatives reported satisfaction with the method they used to complete the building's certification. Fully 97% of the representatives stated that they would use their chosen method again for a future building. One possible conclusion is that the company chose the method that it believed would best be suited to the company,

and this decision proved to be satisfactory. It appears that there is not one method which is better than the others, but rather the best method is the one which best meets the company's needs. The breakout of methods is as follows:

- 52% managed the process internally, but outsourced certain steps;
- 35% performed all steps using internal resources; and
- 13% hired an external consult to complete the entire process.

3.5.2 Estimation of Energy Savings

Building representatives may have difficulty in reporting accurate energy savings, since this requires representatives to know the building's energy consumption before achieving Energy Star. Additionally, the building representative may perceive this information to be proprietary and may not be willing to share it over an electronic survey. Regardless, 84% of the Energy Star respondents related that they did experience an energy savings as a result of achieving the Energy Star certification. Furthermore, some respondents were able to in some way quantify their energy savings. Building representatives cited responses between 5% and 25% reduction in annual energy consumption, or savings between \$12,000 and \$300,000 annually. Because responses were anonymous, it is not possible to tie these responses to any specific building characteristic (such as size, age, etc.), but anecdotally, it can be seen that buildings are often achieving real savings following Energy Star certification. All responses regarding energy savings are shown in Appendix 26.

3.5.3 Estimation of Time Spent to Achieve Energy Star Certification

Similarly, Energy Star building representatives were asked to provide an estimate to the amount of time spent to achieve the certification. While it would be difficult to draw statistical conclusions on this data, respondents cited between 5 and 150 hours spent, with an estimated average of approximately 53 hours. The responses also provide anecdotal information regarding time requirements. All responses regarding time to achieve the certification are shown in Appendix 27.

3.5.4 Estimation of Cost to Achieve Energy Star Certification

The approximate costs associated with achieving the certification is also difficult to ascertain over an electronic survey, but the survey did receive 23 responses that quantified the costs in some way. It appears that two distinct profiles exist within these responses. Fully 74% of these respondents indicate that they were able to achieve the certification at a reasonable cost of less than \$8,000. It appears that many of these respondents were able to complete the entire certification process in-house, or with only the cost of an outside engineer. The second group, 26% of respondents, cited costs between \$75,000 and \$300,000. The difference in costs between these two groups suggests that the second group incurred costs related to items such as building commissioning, building upgrades, or mechanical equipment. All responses regarding costs related to achieving the Energy Star certification are shown in Appendix 28.

3.5.5 Main Reasons for Energy Star Buildings to Recertify

Finally, many Energy Star building representatives plan to recertify their buildings, and they provided the main reasons why they intend to do so. The full responses are included in Appendix 29, but the reasons can be grouped into several

general categories. Once the building representatives had achieved the building's certification and were more fully aware of the actual implications, they cited the following as their main reasons for continuing to pursue Energy Star.

Table 10: Main Reason for Recertifying an Energy Star Building

| | |
|-----|--------------------------------------|
| 21% | Energy Savings |
| 18% | Marketing |
| 18% | To Benchmark Against Other Buildings |
| 14% | Owner initiative |
| 11% | Energy Star Program Delivers Value |
| 11% | Tool to Monitor Building Performance |
| 7% | Helps Achieve LEED certification |

3.6 Analysis Regarding Building Age and Size

A further hypothesis is that statistically significant differences may exist according to the buildings' ages for all buildings surveyed. To test this hypothesis, the responses were grouped into three categories, where each category contains buildings in both the Energy Star group and Comparable Buildings group:

- Group A: Buildings built in the 2000's (between 2000 and 2008)
- Group B: Buildings built in the 1990's (between 1990 and 1999)
- Group C: Buildings built in the 1980's (between 1980 and 1989)

Then hypothesis testing was conducted for the mean responses between Group A and Group B, and between Group B and Group C. For all comparisons, the null hypothesis stated that there was no statistically significant difference between the mean responses of the two groups. The intent was to identify if the building's age resulted in statistically significant differences in the answers to particular questions, and this was

achieved when the statistical analysis led the null hypothesis to be rejected. In fact, the results did identify some noteworthy differences for the following three questions, in which the null hypothesis was rejected:

Table 11: Mean Responses Affected by Building Age

| Question | Rejection of Null Hypothesis between Groups: | Group A (2000's) mean | Group B (1990's) mean | Group C (1980's) mean |
|--|--|-----------------------|-----------------------|-----------------------|
| Question 3: My company is aware of the steps and costs involved to obtain an Energy Star certification for this building. | A and B B and C | 1.36 | 2.31 | 1.35 |
| Question 10: There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program. | A and B | 3.14 | 2.38 | 3.00 |
| Question 13: My company plans to seek Energy Star certification on other buildings. | A and B | 1.50 | 2.15 | 1.76 |
| Question 6: In order to perform the steps to achieve Energy Star certification, this building requires other upgrades to bring the building up to the current building code. | None rejected | 1.86 | 1.54 | 1.53 |

When taken together, the results from these questions identify a notable trend. For all three questions, the difference in mean responses between Group B (those built in the 1990's) and Group A (those built in the 2000's) is statistically significant. Also, there appears to be a difference between Group B mean responses and Group C mean responses, although this was only proven to be statistically significant for Question #3. In fact, the mean responses for Group A and Group C appear to be most similar, while Group B is the outlier. This seems to imply the following:

- The representatives of 2000's buildings and 1980's buildings are more aware of the steps and costs involved to obtain an Energy Star certification, than representatives of

1990's buildings.

- The representatives of 2000's buildings and 1980's buildings have fewer differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program, when compared to representatives of 1990's buildings.
- The representatives of 2000's buildings and 1980's buildings are more inclined to seek Energy Star certification on other buildings, when compared to representatives of 1990's buildings.

Although it did not quite achieve statistical significance (t statistic of 1.86 less than the required critical value of 2.060), a comparison of mean responses for Question #6 shows that 1990's buildings do require more upgrades to bring the building up to the current building code, when compared to 2000's buildings.

The combination of these results seem to point to a common theme, that for some reason, 1990's buildings require more work to achieve Energy Star certification, and the scope of that work is not fully understood by the buildings' representatives, and building representatives disagree about the relationship of the work required relative to the expected benefits. Further study may be able identify the exact causes of these results, and is worth pursuing in order to identify ways to overcome these barriers to achieving the Energy Star certification. The full statistical analysis is provided in Appendices 46-58.

A similar analysis was conducted regarding the buildings' sizes. Buildings were divided into two groups: those that were smaller than 300,000 square feet, and those that were larger than 300,000 square feet. This building size represented an approximate break point, with close to 50% of buildings on either side of the break point. The intent

of this analysis was to understand if a building's size had an impact on the building representatives' responses regarding Energy Star. The null hypothesis for each question stated that there is no statistically significant difference between the mean responses of smaller buildings versus larger buildings. After a full analysis for each question, none of the null hypotheses were rejected, thus it can be concluded that there is no statistically significant difference between buildings smaller than 300,000 square feet or larger than 300,000 square feet at the 0.05 significance level, with regards to their attitudes regarding the Energy Star certification process.

3.7 Innovative Practices

After more fully understanding the current environment for commercial office space in metro Atlanta, we can also examine the measures that other jurisdictions are taking to promote energy efficiency in their buildings. As earlier mentioned in this analysis, many jurisdictions are participating in the Energy Star Challenge (promoted by the EPA's Energy Star program) or in separate energy challenges, such as the State of Georgia's Energy Challenge. Yudelson Associates recently completed a study regarding green building incentives for the National Association of Industrial and Office Properties, although many of these incentives pertain to new construction (Yudelson Associates, 2007). All of these programs will likely result in a certain level of increased awareness for energy conservation; however, there are a few programs and initiatives which have gone beyond the voluntary challenge for existing buildings and are therefore worthy of discussion.

3.7.1 Oregon Energy Trust

Oregon Energy Trust is a nonprofit organization founded in 2002 towards a goal of changing the way Oregonians consume energy by investing in energy efficient technologies. It is funded by a 1999 energy restructuring law which required Oregon's utility providers to collect a 3% "public purposes charge" from customers. In 2007, Energy Trust received approximately \$56 million in revenue from this charge. These aggregated charges are then invested, and the Energy Trust provides cash incentives for its commercial program, home program, and renewable energy program. For its commercial program, these incentives can be achieved by implementing energy efficient measures such as HVAC systems, insulation, lighting, and solar equipment. The intent of the program is to help offset the above-market costs of energy-efficient technologies, such that they are widely adapted given their increased affordability (Energy Trust, n.d.). It would seem that such a program would benefit any jurisdiction, and research was conducted to identify any similar programs in the Atlanta area. However, messages to prominent Atlanta area electricity providers were unanswered, which seems to indicate that such programs do not exist.

3.7.2 State of California

The State of California, known for its progressive energy and environmental policies, recently passed legislation in 2007 which requires all commercial office buildings to generate an Energy Star building rating using Energy Star's free online tools beginning in 2010. As passed into law, Bill AB 1003 requires all nonresidential buildings in the state to provide benchmarking data to prospective buyers, lessees, or lenders, also beginning in 2010 (California Chronicle, 2007). The Energy Star building

rating will be used as a benchmark to assess how efficiently a building uses energy relative to similar buildings nationwide.

In order to support this benchmarking requirement, California's legislation also requires electric utilities to maintain records of energy consumption data in a format compatible with the Energy Star building rating system. In effect, this serves to make the Energy Star benchmarking process as easy as possible, by removing possible difficulties that building representatives may encounter.

3.7.3 Washington D.C.

Washington D.C. recently followed suit by the passage of similar legislation. The Clean and Affordable Energy Act of 2008 makes Washington D.C. the first city to require annual energy benchmarking for buildings. The intent of the legislation is to promote transparency in energy consumption. The program will be phased in over time; buildings larger than 200,000 square feet will be required to comply in 2010, and the size requirement will drop by 50,000 square feet each year until 2013, when all 50,000+ square foot buildings will be required to report energy scores. The intent is to initially promote the program with larger buildings, so that smaller buildings will have examples to follow.

Cliff Majersik, the Program Director of the Institute for Market Transformation which helped to create the legislation, relates additional insights into the impacts of such legislation. He estimates that the program will help to create market demand for energy reporting long before all buildings are required to do so in 2013 (Burr, "In Washington," 2008), and he reports that he is already seeing participation take place. Additionally, cities and states around the country have expressed interest in enacting similar legislation

in their own jurisdictions; therefore it is likely that this movement will spread quickly (C. Majersik, personal communication, April 10, 2009). Furthermore, he provided sample language that can be used to craft legislation within any jurisdiction; this sample language is included as Appendix 59.

It is important to consider how the metro Washington D.C. and metro Atlanta areas compare in regards to their commercial office space. A question arises as to whether the commercial office market in Washington D.C. is in some way better prepared to incorporate this energy benchmarking legislation relative to other office markets. For the sake of comparison, the total inventories of commercial office space have been estimated per city, along with the total inventories of Energy Star office space per city. While it may be quite difficult to draw exact conclusions across two different metro areas, this analysis is reasonable given the use of consistent data sources for both markets.

Table 12: Energy Star Office Space Comparison, Atlanta and Washington D.C.

Source: Energy Star, Transwestern.

| | Atlanta | Washington DC. | Source |
|-----------------------------------|-------------|----------------|--|
| Total SF Energy Star Office Space | 31,007,808 | 28,185,859 | Energy Star |
| Total SF Commercial Office Space | 190,700,000 | 124,369,855 | Transwestern Market Reports, Year End 2008 |
| % Energy Star Space | 16% | 23% | |

First, the Atlanta and Washington D.C. areas appear to have achieved a very comparable total Energy Star inventory, varying only by 3 million square feet; this may

demonstrate that both cities have a comparable level of awareness and ability to achieve the Energy Star certification. However, Atlanta has achieved a smaller percentage of Energy Star office space relative to its total inventory; it has 16%, compared to Washington's 23%. This may suggest that Washington is somewhat more accomplished in achieving Energy Star office space, and this accomplishment is likely affected by a number of factors which are beyond the scope of this analysis.

Importantly, neither California's nor Washington's laws require buildings to *become* Energy Star certified; they simply require the building's energy performance to be measured. All buildings can use Energy's Star's free online software to determine the building's score. The process is free, and requires a relatively small time commitment.

It is possible that a significant step to overcome in order to be compliant with such legislation is the building's ability to provide historical data on the building's energy consumption. It's hard to imagine buying a car without knowing its miles per gallon; or buying groceries without knowing their nutritional content. Yet, there is nothing that requires buildings to provide this performance data, so it is possible that some buildings may not currently provide energy performance data that can inform decisions to rent or buy that building. The new legislation in the State of California and Washington D.C. would remove that barrier, by requiring all commercial building representatives to provide their building's energy rating. If they have not already done so, building representatives must begin collecting their building's energy consumption on a monthly basis so as to generate an energy score based on a prior 12-month reporting period.

Both California's and Washington's policies demonstrate a precedence for a lead time to require this type of measure. These legislations, signed in 2007 and 2008, require

compliance beginning in 2010. Thus, between 2-3 years appears to be an acceptable time period to publicize and enable compliance of the new requirements.

Both California and Washington D.C. have reason to enact energy-efficient legislation. California is likely motivated by its high energy costs and environmentally-minded culture. Washington D.C. is taking the position to lead by example as the country's largest concentration of federal government buildings. Washington acknowledges that commercial buildings represent the city's primary source of CO₂, and are using the legislation as a tool to fight climate change (C. Majersik, personal communication, April 10, 2009). As a result of the circumstances these two areas face, the governing entities have taken stances to encourage the private sector to take the first step towards increased energy efficiency. It may be a matter of time before other jurisdictions come to the same conclusion, including those in Georgia.

CHAPTER 4

DISCUSSION OF RESULTS

The final piece of this analysis is to summarize the new contribution of knowledge that has resulted from this study. The study demonstrates that increasing energy efficiency in existing buildings does represent an opportunity for companies and the metro Atlanta area. In addition, this study has identified the most significant differences that exist between Energy Star and Comparable Buildings, conclusions regarding Energy Star buildings, and realities involved with achieving the Energy Star certification.

U.S. Office Sector's Contribution of Energy Consumption

Users within the U.S. Office sector consume approximately 251 billion kilowatt hours of electricity on an annual basis. This energy consumption results in approximately 165 million tons of CO₂ emissions annually. This calculation has not been found in any previous research, and it provides a unique view to the specific impact that the office sector makes.

Strong Opportunity to Improve Energy Efficiency in Existing Buildings

While recent attention has been placed on increasing energy efficiency in newly constructed buildings when it is easiest to do so, a much greater opportunity exists to improve energy efficiency in existing buildings. Compared to the estimated annual new construction of 7 million square feet of office and institutional space in the U.S., the

existing stock of 65 million existing square feet of U.S. office space represents the area in which energy efficiency efforts can make a significantly larger impact.

Energy Efficiency Efforts in Georgia Exist, but are Underutilized

Various certification programs, legislation, and voluntary programs have evolved to encourage energy efficiency in existing buildings, but they are underutilized in Georgia. While the Energy Star certification program for commercial office buildings has existed for approximately 10 years, only 16% of metro Atlanta's office space has achieved the certification. Several state and local governments have enacted legislation which references the Energy Star program for existing office buildings, but local Georgia governments have not yet done so. Georgia and its local areas have not adopted voluntary energy efficiency programs to the extent that other states have, such as informal challenges to reduce energy consumption, and only approximately 25% of available 2008 tax credits were awarded.

Statistically Significant Differences between Energy Star and Comparable Buildings

The following three differences were proven to be statistically significant between Energy Star buildings and Comparable Buildings, and are supported by *t* statistic analysis which resulted in rejecting the null hypothesis (at the 0.05 significance level) that the two groups do not have statistically significant differences for particular comparisons. The identification of these statistically significant differences between Energy Star and Comparable Buildings provides information as to where Comparable Buildings should focus efforts in order to prepare themselves to achieve the Energy Star certification.

1. Energy Star buildings have a higher Energy Star building rating, which indicates these buildings use energy more efficiently. The mean Energy Star building rating was 82, while the mean Comparable Building score, for those that had received one, was 63. The statistically significant difference was proven with the resulting t statistic of 8.684 for Comparison #11.

2. The representatives of Energy Star buildings have historically had available budgets which were sufficient to accomplish any required improvements or upgrades in order to achieve the Energy Star certification, which may involve other building improvements required to bring the building up to the current building code. This conclusion is supported by the t statistics of 2.334 for Comparison #6, 2.438 for Comparison #4, and 7.000 for Comparison #7, which indicate statistically significant differences between the two groups.

3. The representatives of Energy Star buildings have more knowledge of how to navigate the process of achieving the Energy Star certification. This conclusion is supported by the t statistic of 3.266 for Comparison #3.

Statistically Significant Conclusions Regarding Energy Star Buildings

Four prominent conclusions can be derived from the statistical analysis of only the respondents from the Energy Star buildings.

1. Achieving the Energy Star certification and the intent to pursue LEED EBOM certification are directly related (as supported by a population mean of 1.194 for Question #12).

2. Energy Star building respondents believe in voluntary energy reduction and greenhouse gas reduction measures (as supported by population means of 1.387, 1.484, and 1.581 for Questions #14, #2, and #1, respectively).
3. Energy Star building respondents intend to pursue recertifying the building through the Energy Star process, and to certify other buildings as well (as supported by population means of 1.613, 1.613, 1.742, and 1.774 for Questions #15, #5, #13, and #16, respectively).
4. Energy Star buildings were able to achieve the certification, despite having to make other improvements to bring the building up to the current building code (as supported by a population mean of 1.742 for Question #6).

Realities Involved in Achieving Energy Star Certification

In order to better inform building representatives about the realities of obtaining the Energy Star certification, Energy Star building respondents' answers reveal concrete evidence regarding their experiences. While results will vary for each building based on a number of factors, this analysis establishes a concrete framework around realistic expectations regarding the process to obtain Energy Star certification. This information may prove helpful for representatives of Comparable Buildings who seek to obtain the certification themselves.

- 97% of Energy Star building respondents were satisfied with their method used to achieve Energy Star certification, which indicates that the best method is the one which best meets the company's needs;

- 84% of Energy Star building respondents experienced energy savings as a result of achieving the Energy Star certification. For those who were able to quantify actual savings, respondents cited between 5% and 25% savings, between \$12,000 and \$300,000 annually.
- Energy Star respondents cited an average of 53 required hours to obtain the Energy Star certification.
- Regarding costs, fully 74% of Energy Star respondents cited a cost of less than \$8,000 to achieve the Energy Star certification. The remaining 26% cited costs between \$75,000 and \$300,000, which indicates this group incurred costs related to building upgrades or other processes in order to achieve the certification.
- Energy Star building respondents cited a variety of reasons why they intend to pursue recertification of their buildings; reasons include energy savings, marketing, benchmarking, owner initiative, value of the program, useful tool to monitor building performance, and assistance in achieving LEED certification.

Building Age Plays a Role in Building Representatives' Responses

The age of a building does appear to affect building representatives' responses. When compared to 1990's buildings, the representatives of metro Atlanta office buildings built in the 2000's or the 1980's display the following characteristics:

- They are more aware of the steps and costs involved with the Energy Star certification process;
- They cite fewer differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program; and

- They are more inclined to seek Energy Star certification on other buildings in their portfolios.

The root cause of these differences was not explored in this project, and this represents a possible topic for further study.

CHAPTER 5

CONCLUSION

It is becoming increasingly apparent that there is much to be gained by increasing the level of energy efficiency in office buildings. Many building representatives recognize value in obtaining an Energy Star certification, which provides an independently-verified measure of a building's efficient use of energy. Using Atlanta as a proxy for the entire stock of office buildings, this research validated the conclusion that the program may currently be underutilized as a result of various impediments to implementing the process. This analysis sought to more clearly understand the degree to which the Energy Star program does in fact offer value to building owners, and to identify measures that may result in increased participation in the program.

Specifically for Energy Star buildings, four conclusions were found. First, Energy Star buildings are also pursuing LEED certification. Secondly, Energy Star building representatives believe in voluntary energy reduction and greenhouse gas reduction measures. Third, these building representatives plan to recertify the building and certify other buildings in their portfolio. Finally, Energy Star buildings were able to achieve the certification despite having to make other improvements to bring the building up to the current building code.

As recommendations for further scope, this research could be continued in the following ways:

- Energy Star buildings could be studied further, to more fully understand specific details regarding various types of upgrades that may be required, and to identify the associated costs and energy efficiency benefits of those upgrades.
- Further investigation could be conducted regarding the differences in office buildings built in the 1990's, to identify exact reasons why these buildings appear to less understood or more difficult to achieve Energy Star certification.
- The political environment and public policy factors in the Atlanta area should be evaluated to determine the viability of implementing energy-efficiency related legislation or the feasibility of creating public-purpose organizations.
- Additional personal interviews could be conducted with respondents, to more fully understand details around responses given in the electronic survey.
- Further investigation could be conducted with Comparable Buildings, to more fully understand reasons why some buildings have not yet obtained a building rating using the Energy Star Portfolio Manager tool.
- An analysis between cities could be conducted to understand which, if any, characteristics about the city, its buildings, its politics, or its policies, affect a building's ability to obtain the Energy Star certification.

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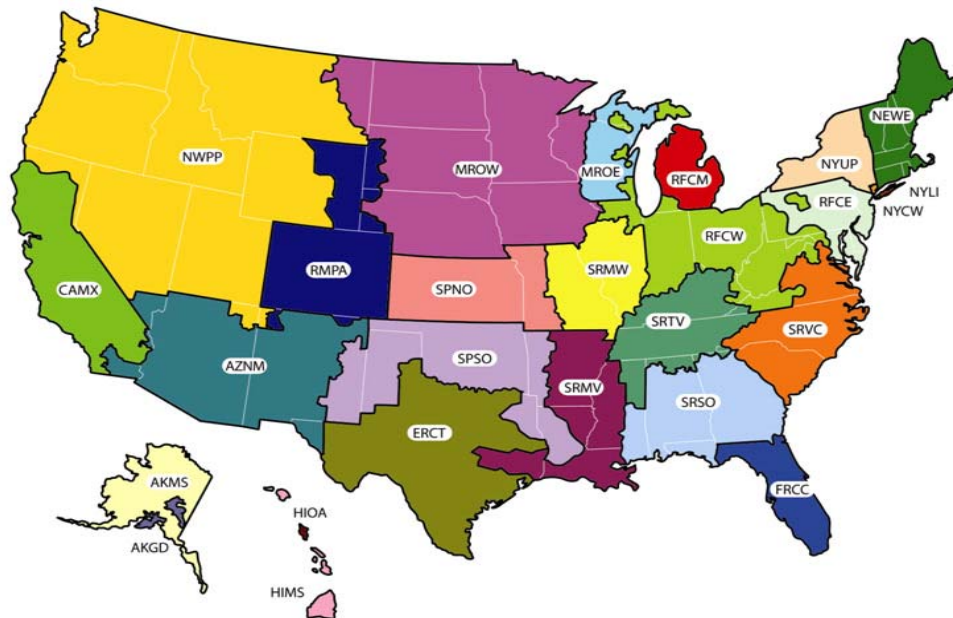
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Appendix 1
2005 Greenhouse Gas Annual Output Emission Rates
Source: EPA's Emissions & Generation Resource Integrated Database (www.epa.gov/egrid)

| eGRID subregion acronym | eGRID subregion name | Carbon Dioxide (CO ₂) (lb / MWh) |
|-------------------------|----------------------|--|
| AKGD | ASCC Alaska Grid | 1,213.49 |
| AKMS | ASCC Miscellaneous | 498.90 |
| AZNM | WECC Southwest | 1,311.05 |
| CAMX | WECC California | 712.99 |
| ERCT | ERCOT All | 1,324.35 |
| FRCC | FRCC All | 1,264.50 |
| HIMS | HICC Miscellaneous | 1,415.73 |
| HIOA | HICC Oahu | 1,737.38 |
| MORE | MRO East | 1,812.91 |
| MROW | MRO West | 1,810.47 |
| NEWE | NPCC New England | 829.41 |
| NWPP | WECC Northwest | 898.04 |
| NYCW | NPCC NYC/Westchester | 781.11 |

| eGRID subregion acronym | eGRID subregion name | Carbon Dioxide (CO ₂) (lb / MWh) |
|-------------------------|--------------------------|--|
| NYLI | NPCC Long Island | 1,353.45 |
| NYEP | NPCC Upstate NY | 699.63 |
| RFCE | RFC East | 1,090.50 |
| FRFCM | RFC Michigan | 1,543.33 |
| RFCW | RFC West | 1,536.99 |
| RMPA | WECC Rockies | 1,870.19 |
| SPNO | SPP North | 1,960.94 |
| SPSO | SPP South | 1,655.25 |
| SRMV | SERC Mississippi Valley | 1,017.49 |
| SRMW | SERC Midwest | 1,830.27 |
| SRSO | SERC South | 1,476.99 |
| SRTV | SERC Tennessee Valley | 1,509.94 |
| SRVC | SERC Virginia / Carolina | 1,118.40 |

Average = 1,318.22



Appendix 2
State and Local Legislation Leveraging Energy Star
Source: www.energystar.gov

| State / Municipality | Legislation | Summary |
|-----------------------------|----------------------------------|--|
| Borough of West Chester, PA | Borough Ordinance | This Ordinance requires that new commercial construction shall be "Designed to Earn the ENERGY STAR" and be benchmarked annually in EPA's Portfolio Manager. |
| City of Denver, CO | Executive Order 123 | Executive Order 123 requires new construction and major renovations of city buildings to be "Designed to Earn the ENERGY STAR" and requires benchmarking in Portfolio Manager for existing and future city-owned and operated buildings. |
| District of Columbia | Green Building Act of 2006 | The Green Building Act of 2006 requires District-owned commercial building to be "Designed to achieve 75 points on the EPA national energy performance rating system as determined by the ENERGY STAR Target Finder tool" and be benchmarked annually using EPA's Portfolio Manager. |
| State of CA | AB 1003, 2007 | Assembly Bill 1103 requires, as of January 1, 2009, electric and gas utilities to maintain and make available to building owners the energy consumption data of all nonresidential buildings in a format compatible for uploading to EPA's Portfolio Manager tool. It also requires, as of January 1, 2010, that a nonresidential building owner or operator disclose Portfolio Manager benchmarking data and ratings to a prospective buyer, lessee, or lender as part of a whole-building transaction. |
| State of IL | SJ 27, 2007 | Senate Joint Resolution 27, 2007 establishes that for all state buildings, "new construction of buildings shall be designed to and achieve a minimum delivered fossilfuel GHG emitting energy consumption performance standard of one-half the U.S. average for that building type as defined in EPA's Target Finder tool." It also calls for standards to continue increasing until all new construction is designed to be carbon neutral by 2030. |
| State of MI | EO 2005-4, 2005 | Executive Order 2005-4 requires the Department of Management and Budget to establish an energy efficiency savings target for all state buildings managed by the Department or another department or agency within the Executive Branch of state government. It requires that all state buildings occupied by state employees be benchmarked using Portfolio Manager. |
| State of MN | Next Generation Energy Act, 2007 | The Next Generation Energy Act of 2007 directs the state's public utilities commission to adjust utilities' performance incentives so they align with an annual energy-savings goal equal to 1.5 percent of their retail energy sales. The bill also sets a state goal of earning ENERGY STAR labels for 1,000 commercial buildings by the end of 2010. |
| State of OH | EO 2007-02 | Executive Order 2007-02 establishes that the State of Ohio will use EPA's Portfolio Manager as the benchmarking tool for state-owned facilities to establish building baselines and measure and track energy use and carbon emissions within the state. |
| Commonwealth of VA | EO 48, 2007 | Executive Order 48 (2007) requires all new state-owned facilities over 5,000 ft ² and selected renovations of buildings to be designed and constructed consistent with energy performance standards at least as stringent as EPA's ENERGY STAR rating or the U.S. Green Building Council's LEED® rating system. It also instructs state agencies leasing space in buildings to give preference to buildings that have earned the ENERGY STAR when executing a new lease or extending an existing lease. |

Appendix 3

BOMA 7-Point Challenge

Source: www.boma.org

MARKET TRANSFORMATION

The Building Owners and Managers Association (BOMA) International recognizes that current research estimates that energy consumption in commercial buildings accounts for 18 percent of U.S. greenhouse gas (GHG) emissions. BOMA also recognizes that responsible building operating and management practices can significantly reduce energy consumption, diminish a building's carbon footprint, and thus lower GHG emissions. By working with real estate professionals, through our network of 92 local BOMA associations with all levels of government, and the myriad of public and private groups with similar goals, market transformation will be realized.

Commercial real estate owners and operators understand the triple bottom line of reducing energy consumption and implementing "green" management practices is a social and environmental responsibility, and can result in a positive return on investment (ROI).

BOMA INTERNATIONAL CALLS UPON ITS MEMBERS TO ACCEPT THIS 7-POINT CHALLENGE TO REDUCE THE USE OF NATURAL RESOURCES, NON-RENEWABLE ENERGY SOURCES, AND WASTE PRODUCTION AND WORK IN COORDINATION WITH BUILDING MANAGEMENT, OWNERSHIP AND TENANTS TO ACHIEVE THE FOLLOWING GOALS

1. Continue to work towards a goal to decrease energy consumption by 30 percent across your portfolios by 2012 – as measured against an "average building" measuring a 50 on the ENERGY STAR® benchmarking tool in 2007;
2. At least once a year, benchmark your energy performance and water usage through EPA's ENERGY STAR benchmarking tool and share your results with BOMA;
3. Provide education to your managers, engineers and others involved in building operations, to ensure that equipment is properly installed, commissioned, maintained and utilized;
4. Perform an energy audit and/or retro-commissioning of your building, and implement low-risk, low-cost and cost effective strategies to improve energy efficiency with high returns;
5. Extend equipment life by improving the operations and maintenance of building systems and ensure equipment is operating as designed;
6. Through leadership, positively impact your community and your planet by helping to reduce your industry's role in global warming; and
7. Position yourself and the industry as leaders and solution providers to owners and tenants seeking environmental and operational excellence.

BOMA International believes that through implementation of these no- and low-cost operation and management practices, buildings may see a reduction in energy consumption alone of up to 30 percent. In addition to lowering operating costs and enhancing asset value, these measures will improve tenant comfort and satisfaction with better building temperature control and lower absenteeism and increase your tenants' productivity, resulting in real cost savings for tenants.

BOMA International also calls on its network of 92 federated local associations to accept the challenge to work at the local and state level to implement responsible government programs and voluntary incentives to facilitate market transformation.

SPECIFICALLY, WE CALL ON BOMA LOCAL ASSOCIATIONS TO:

1. Partner with local government, other industry groups and associations, as well as utilities, to identify voluntary energy efficiency strategies with proven results and application to existing buildings;
2. Partner with local government to share education and case studies on no- and low-cost building operating and management practices to assist in efforts to transform state and municipal buildings;
3. Work with policymakers to enact voluntary, incentive-based programs to accomplish their goals of implementing green communities; and
4. Work cooperatively with state and local government to update, at a reasonable frequency, its model building and energy codes.

BOMA INTERNATIONAL BELIEVES THAT MARKET TRANSFORMATION IS THE MOST IMPORTANT CONTRIBUTION OUR ASSOCIATION CAN MAKE TO OUR SOCIETY AND TO OUR COMMUNITIES. IN ADDITION TO ENCOURAGING OUR MEMBERS AND NETWORK OF LOCAL ASSOCIATIONS TO WORK TO IMPLEMENT ENVIRONMENTALLY AND SOCIALLY RESPONSIBLE BUILDING MANAGEMENT PRACTICES THAT RESULT IN REDUCED RELIANCE ON NON-RENEWABLE RESOURCES AND A FAVORABLE RETURN ON INVESTMENT, BOMA PLEDGES TO:

1. Work with our members to encourage them to decrease energy consumption by 30 percent across their portfolios by 2012. However, we understand that many buildings have already achieved these reductions, and some older buildings may not be able to attain this level of energy reduction;
2. Continue to develop education programs for building owners and managers that can result in immediate reduction of energy consumption and reduce energy costs by as much as 30 percent;
3. Join forces with other organizations, the scientific research community and industry leaders engaged in issues related to sustainable building operating and management practices to facilitate the dialogue, conduct any needed research, share knowledge and best practices, and accelerate market transformation;
4. Participate in building codes and standards development efforts for energy efficiency and green buildings standards that promote aggressive but attainable and cost-effective results;
5. Work with the United States Congress, Administration and federal agencies to implement responsible energy policy that encourages voluntary action and resorts to mandates only with commensurate and offsetting incentives;
6. Promote documentation and benchmarking, through the EPA ENERGY STAR benchmarking tool (for energy and water), of the measurable contributions resulting from implemented sustainable operation and management approaches;
7. Promote research by industry, scientific, and governmental entities to provide the commercial real estate industry with full life cycle assessment data for all products, materials and equipment used in the construction, operation and management of the built environment to facilitate decision-making;
8. Promote research that will result in technological advances necessary to make buildings operate even more efficiently and achieve the goal of carbon-neutral buildings;
9. Communicate the benefits of environmentally responsible management practices, including higher occupancy rates, rental rates, asset value, and tenant satisfaction, to both the public and private sector;
10. Work with utilities to encourage voluntary demand-side management (DSM) and rebate programs to encourage energy efficiency;
11. Assume a global leadership role as advocates for sustainable operations and management practices in the built environment and share knowledge and promote sustainable practices throughout the world.

TO SIGN ON TO BOMA'S 7 POINT CHALLENGE, CONTACT KAREN PENAFIEL AT KPENAFIEL@BOMA.ORG.

Appendix 4

BOMA 7-Point Challenge Endorsement List

Source: www.boma.org



BOMA International wishes to thank the companies and local associations that have endorsed the 7-Point Challenge to reduce energy consumption and help the environment. The endorsers of the 7-Point Challenge include:

BOMA Member Companies

Advance Realty Group
Akridge
The Ashforth Company
Brookfield Properties
California Plaza
Carr Services
CB Richard Ellis
CNL Commercial Real Estate
Colonial Properties Trust
Cousins Properties
Coventry Health Care
Crescent Real Estate
Crescent Resources, LLC
Crimson Services, LLC
Cushman & Wakefield
Eastman Management Corporation
Glenborough, LLC
Granite Properties, Inc.
Great American Insurance Building
Management
Hallmark Partners, Inc.
Harbor Group Management Company
Hines
The Irvine Company
LBA Realty

Liberty Property Trust
Lincoln Property Company
Lowe Enterprises Real Estate Group
Means Knaus LLP
Merritt 7 Venture LLC
MetroNational
Opus
Parkway Properties, Inc.
Parmenter Realty Partners
PM Realty Group
RiverRock Real Estate Group
RREEF
Ryan Companies US, Inc.
Shorenstein Properties, LLC
Stream Realty Partners, L.P.
Thomas Properties Group
Transwestern
Unico Properties LLC
USAA Real Estate Co.
U.S. Equities Realty
Washington Real Estate Investment Trust
Wealth Capital Management, Inc. (Bank
of America Tower at International Place)
Wells Real Estate Funds
Zimmer Real Estate Services, L.C.

BOMA Local Associations

Austin
Baltimore
Birmingham
Boise
Boston
Buffalo
Chattanooga
Chicago
Cincinnati
Greater Cleveland
Columbus
Dallas
Denver Metro
Metropolitan Detroit
Fort Lauderdale/Palm Beaches
Hawaii
Houston
Kansas City
Greater Hartford
Greater Los Angeles
Greater Tampa Bay
Inland Empire
Iowa
Jacksonville
Miami-Dade
Minneapolis
Nashville
New Jersey
New Mexico
New York
Oakland-East Bay
Omaha
Orange County
Orlando
Philadelphia
Pittsburgh
Phoenix
Portland
Raleigh-Durham
Sacramento
San Antonio
San Diego
San Francisco

Seattle-King County
Silicon Valley
Southern Connecticut
Spokane
St. Louis
Suburban Chicago
Southwest Florida
Tallahassee
Utah
Virginia
Metropolitan Washington
Westchester

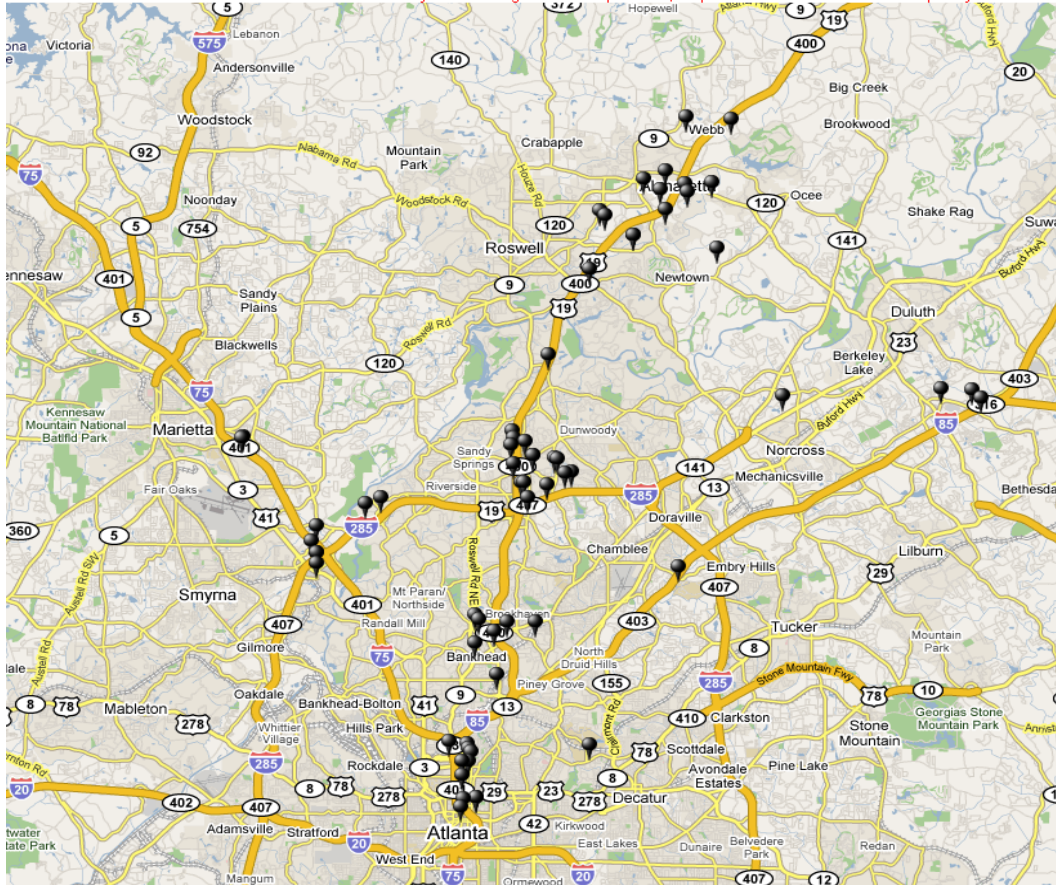
BOMA State Coalitions

California
Florida

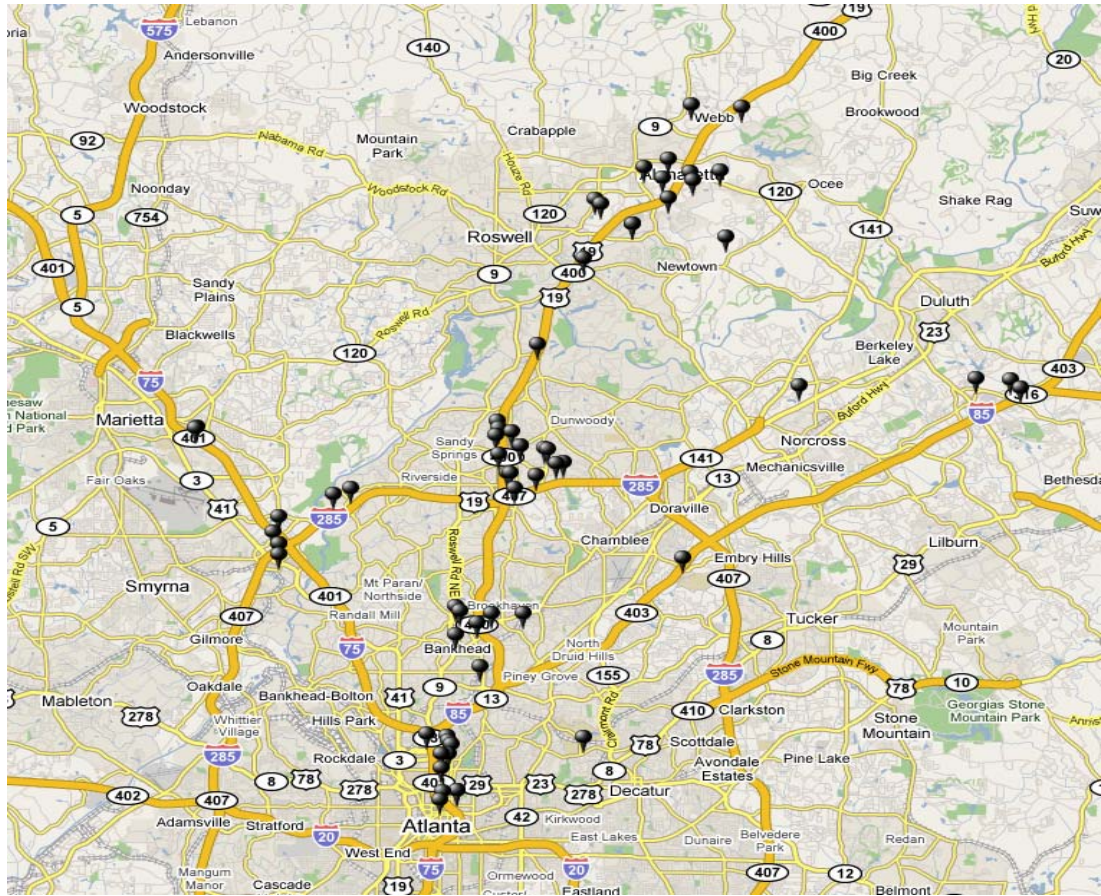
Public Sector

EPA Energy Star
Omaha Douglas Public Building
Commission

Appendix 5
Locations of Energy Star Buildings
Source: Energy Star, www.mapalists.com



Appendix 6
Locations of Comparable Buildings
Source: CoStar, www.mapalist.com



Appendix 7: Energy Star Commercial Building Survey

- 1** Even though Energy Star certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 2** It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 3** My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 4** In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 5** My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 6** In order to perform the steps to achieve Energy Star certification, this building required other upgrades to bring the building up to the current building code.

| | |
|------------|-----------|
| YES | NO |
|------------|-----------|

- 7 My company's budget was sufficient to accommodate the cost of these upgrades that brought the building up to the current building code.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 8 This building currently performs well, and does not need energy-efficient improvements.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 9 My company believes a third-party certification is valuable.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 10 There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 11 Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software.

- 12 My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building.

| | |
|-----|----|
| YES | NO |
|-----|----|

13 My company plans to seek Energy Star certification on other buildings.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

14 My company plans to continuously seek ways to improve this building's energy efficiency.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

15 My company plans to continue to track this building's performance through Energy Star's Portfolio Manager software.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

16 Since this building's original Energy Star certification, we have recertified the building on a regular basis, or plan to maintain this building's Energy Star certification in the future by going through the certification process each year.

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

17 Please provide the main reason why you plan to recertify the building through the Energy Star program.

| | |
|-------------|-------------|
| <div></div> | <div></div> |
|-------------|-------------|

18 How did your company actually perform the steps to achieve

Energy Star certification?

- ☐ My company performed all steps using internal resources.
- ☐ My company managed the process internally, but outsourced certain steps.
- ☐ My company hired an external consultant to complete the entire process.
- ☐ Other, please specify

19 If you were to certify another building through the Energy Star process, would you choose the same strategy again?

20 If not, which strategy would you use instead?

- ☐ Perform all steps using internal resources.
- ☐ Manage the process internally, but outsource certain steps.
- ☐ Hire an external consultant to complete the entire process.
- ☐ Other, please specify

21 Does your building save energy following its Energy Star certification?

22 If yes, please provide an estimate of annual energy savings, either in terms of dollars or kWh.

23 What is the total size of this building?

- ☐ Less than 100,000 square feet
- ☐ 100,000 to 200,000 square feet
- ☐ 200,000 to 300,000 square feet
- ☐ 300,000 to 400,000 square feet
- ☐ 400,000 to 500,000 square feet
- ☐ More than 500,000 square feet

24 In what year was this building constructed?

- ☐ 2000 - 2008
- ☐ 1990 - 1999
- ☐ 1980 - 1989
- ☐ 1970 - 1979
- ☐ Before 1970

25 If known, what was the estimated number of man-hours spent to achieve Energy Star certification for this building?

26 If known, what was the estimated total cost to achieve Energy Star certification for this building?

27 Optional: Is there any other information you would like to provide related to the energy efficiency of this building or energy efficiency efforts your company has pursued?

Appendix 8: Comparable Commercial Building Survey

- 1 Even though Energy Star certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 2 It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 3 My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 4 In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 5 My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 6 In order to perform the steps to achieve Energy Star certification, this building requires other upgrades to bring the building up to the current building code.

| | |
|-----|----|
| YES | NO |
|-----|----|

- 7 My company's budget is sufficient to accommodate the cost of these upgrades that will bring the building up to the current building code.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 8 This building currently performs well, and does not need energy-efficient improvements.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 9 My company believes a third-party certification is valuable.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 10 There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

- 11 Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software.

- 12 My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building.

| | |
|-----|----|
| YES | NO |
|-----|----|

- 13 My company plans to seek Energy Star certification on **other** buildings that we own or manage.

| | | | | |
|----------------|-------|----------------------------|----------|-------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

14 My company plans to continuously seek ways to improve this building's energy efficiency

| | | | | |
|-------------------|----------|-------------------------------|----------|----------------------|
| Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly Disagree |
| 1 | 2 | 3 | 4 | 5 |

15 What is the total size of this building?

- ☐ Less than 100,000 square feet
- ☐ 100,000 to 200,000 square feet
- ☐ 200,000 to 300,000 square feet
- ☐ 300,000 to 400,000 square feet
- ☐ 400,000 to 500,000 square feet
- ☐ More than 500,000 square feet

16 What year was this building constructed?

- ☐ 2000 - 2008
- ☐ 1990 - 1999
- ☐ 1980 - 1989
- ☐ 1970 - 1979
- ☐ Before 1970

17 I would like more information on how to achieve the Energy Star certification for this building.

YES **NO**

18 Optional: Is there any other information you would like to provide related to the energy efficiency of this building or energy efficiency efforts your company has pursued?

Appendix 9: Calculation of Required Sample Sizes

| Question | Variance | | Standard Deviation | | Sample Size Required | |
|----------|-------------|---------------------|--------------------|---------------------|----------------------|---------------------|
| | Energy Star | Comparable Building | Energy Star | Comparable Building | Energy Star | Comparable Building |
| 1 | 0.52 | 0.74 | 0.720 | 0.862 | 32 | 11 |
| 2 | 0.46 | 0.76 | 0.677 | 0.870 | 28 | 12 |
| 3 | 0.31 | 1.36 | 0.558 | 1.166 | 19 | 21 |
| 4 | 0.80 | 1.19 | 0.894 | 1.092 | 49 | 18 |
| 5 | 0.38 | 0.83 | 0.615 | 0.913 | 23 | 13 |
| 6 | 0.20 | 0.26 | 0.445 | 0.506 | 12 | 4 |
| 7 | 0.29 | 0.21 | 0.535 | 0.463 | 18 | 3 |
| 8 | 1.16 | 0.97 | 1.078 | 0.987 | 71 | 15 |
| 9 | 0.46 | 0.90 | 0.680 | 0.947 | 28 | 14 |
| 10 | 1.03 | 0.59 | 1.016 | 0.768 | 63 | 9 |
| 11 | 270.07 | 995.40 | 16.434 | 31.550 | N/A | N/A |
| 12 | 0.16 | 0.27 | 0.402 | 0.519 | 10 | 4 |
| 13 | 0.53 | 0.91 | 0.729 | 0.954 | 33 | 14 |
| 14 | 0.25 | 0.26 | 0.495 | 0.506 | 15 | 4 |
| 15 | 2.62 | 4.03 | 1.620 | 2.006 | N/A | N/A |
| 16 | 0.77 | 0.64 | 0.875 | 0.801 | N/A | N/A |

| | | |
|--------------|-------|-------|
| Z = | 1.96 | 1.96 |
| Std. Error = | 0.250 | 0.500 |
| avg n = | 31 | 11 |

Appendix 10: Statistical Analysis for Survey Question #1 Comparison

Question 1: Even though Energy Star certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | | | | |
| 2 | 4 | 31 | 1.58 | 0.52 | 2 | 4 | 13 | 2.08 | 0.74 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | 27 | 65 | | | | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 49 | 93 | | | | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.58 | -1.968 | 42 | 0.05 | 2.021 | Accept |

Appendix 11: Statistical Analysis for Survey Question #2 Comparison

Question 2: It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 1.48 | 0.46 | 1 | 1 | 13 | 1.62 | 0.76 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | 21 | 43 | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 46 | 82 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.54 | -0.540 | 42 | 0.05 | 2.021 | Accept |

Appendix 12: Statistical Analysis for Survey Question #3 Comparison

Question 3: My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 1 | 1 | 31 | 1.39 | 0.31 | 1 | 1 | 13 | 2.23 | 1.36 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 4 | 16 | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | 29 | 81 | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 43 | 69 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.61 | -3.266 | 42 | 0.05 | 2.021 | Reject |

Appendix 13: Statistical Analysis for Survey Question #4 Comparison

Question 4: In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | |
| 1 | 1 | 31 | 2.00 | 0.80 | 3 | 9 | 13 | 2.77 | 1.19 | |
| 1 | 1 | | | | 1 | 1 | | | | |
| 1 | 1 | | | | 1 | 1 | | | | |
| 2 | 4 | | | | 4 | 16 | | | | |
| 1 | 1 | | | | 3 | 9 | | | | |
| 4 | 16 | | | | 4 | 16 | | | | |
| 3 | 9 | | | | 2 | 4 | | | | |
| 2 | 4 | | | | 3 | 9 | | | | |
| 3 | 9 | | | | 4 | 16 | | | | |
| 1 | 1 | | | | 2 | 4 | | | | |
| 2 | 4 | | | | 3 | 9 | | | | |
| 2 | 4 | | | | 4 | 16 | | | | |
| 2 | 4 | | | | 2 | 4 | | | | |
| 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | 36 | 114 | | | | |
| 2 | 4 | | | | Sum | Sum | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | |
| 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | | | | | | |
| 2 | 4 | | | | | | | | | |
| 4 | 16 | | | | | | | | | |
| 3 | 9 | | | | | | | | | |
| 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | | | | | | |
| 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | | | | | | |
| 62 | 148 | | | | | | | | | |
| Sum | Sum | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.91 | -2.438 | 42 | 0.05 | 2.021 | Reject |

Appendix 14: Statistical Analysis for Survey Question #5 Comparison

Question 5: My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 1.61 | 0.38 | 2 | 4 | 13 | 2.00 | 0.83 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 4 | 16 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | 26 | 62 | | | | | | |
| 3 | 9 | | | | Sum | Sum | | | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 50 | 92 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.51 | -1.643 | 42 | 0.05 | 2.021 | Accept |

Appendix 15: Statistical Analysis for Survey Question #6 Comparison

Question 6: In order to perform the steps to achieve Energy Star certification, this building requires other upgrades to bring the building up to the current building code.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 1.74 | 0.20 | 2 | 4 | 13 | 1.38 | 0.26 | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | 18 | 28 | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 54 | 100 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|-------|--------------------|-----------------------|----------------|----------|
| 0.21 | 2.334 | 42 | 0.05 | 2.021 | Reject |

Appendix 16: Statistical Analysis for Survey Question #7 Comparison

Question 7: My company's budget was sufficient to accommodate the cost of these upgrades that brought the building up to the current building code.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| | 0 | 8 | 2.00 | 0.29 | | 0 | 8 | 3.75 | 0.21 | | | |
| | 0 | | | | | 0 | | | | | | |
| | 0 | | | | | 0 | | | | | | |
| | 0 | | | | 4 | 16 | | | | | | |
| | 0 | | | | 3 | 9 | | | | | | |
| 2 | 4 | | | | 4 | 16 | | | | | | |
| | 0 | | | | 4 | 16 | | | | | | |
| | 0 | | | | | 0 | | | | | | |
| | 0 | | | | | 0 | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | |
| | 0 | | | | 4 | 16 | | | | | | |
| | 0 | | | | 4 | 16 | | | | | | |
| 2 | 4 | | | | 4 | 16 | | | | | | |
| | 0 | | | | | | | | | | | |
| 1 | 1 | | | | 30 | 114 | | | | | | |
| | 0 | | | | Sum | Sum | | | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| | 0 | | | | | | | | | | | |
| 16 | 34 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.25 | -7.000 | 14 | 0.05 | 2.021 | Reject |

Appendix 17: Statistical Analysis for Survey Question #8 Comparison

Question 8: This building currently performs well, and does not need energy-efficient improvements.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | | | | |
| 3 | 9 | 31 | 2.81 | 1.16 | 3 | 9 | 13 | 3.15 | 0.97 | | | | | | |
| 3 | 9 | | | | 4 | 16 | | | | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | | | | |
| 4 | 16 | | | | 3 | 9 | | | | | | | | | |
| 5 | 25 | | | | 3 | 9 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 4 | 16 | | | | 1 | 1 | | | | | | | | | |
| 3 | 9 | | | | 4 | 16 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 2 | 4 | | | | 4 | 16 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 4 | 16 | | | | 5 | 25 | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | 41 | 141 | | | | | | | | | |
| 1 | 1 | | | | Sum | Sum | | | | | | | | | |
| 4 | 16 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| 87 | 279 | | | | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 1.11 | -0.999 | 42 | 0.05 | 2.021 | Accept |

Appendix 18: Statistical Analysis for Survey Question #9 Comparison

Question 9: My company believes a third-party certification is valuable.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | | | | |
| 2 | 4 | 31 | 2.06 | 0.46 | 2 | 4 | 13 | 2.31 | 0.90 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 4 | 16 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | 30 | 80 | | | | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 64 | 146 | | | | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | | | | |

| S² p | <i>t</i> | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|------------------------|-----------------|---------------------------|------------------------------|-----------------------|-----------------|
| 0.59 | -0.961 | 42 | 0.05 | 2.021 | Accept |

Appendix 19: Statistical Analysis for Survey Question #10 Comparison

Question 10: There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 2.97 | 1.03 | 4 | 16 | 13 | 2.62 | 0.59 | | | |
| 5 | 25 | | | | 4 | 16 | | | | | | |
| 4 | 16 | | | | 3 | 9 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 3 | 9 | | | | | | |
| 4 | 16 | | | | 3 | 9 | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 5 | 25 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 5 | 25 | | | | 34 | 96 | | | | | | |
| 3 | 9 | | | | Sum | Sum | | | | | | |
| 4 | 16 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 92 | 304 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|-------|--------------------|-----------------------|----------------|----------|
| 0.91 | 1.120 | 42 | 0.05 | 2.021 | Accept |

Appendix 20: Statistical Analysis for Survey Question #11 Comparison

Question 11: Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | |
|--------------------------------|-----------------------------|---|--------------------|-----------------------------|-------------------------------|-----------------------------|----------------|--------------------|-----------------------------|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C |
| 78 | 6084 | 31 | 82.00 | 270.07 | 49 | 2401 | 13 | 19.31 | 995.40 |
| 84 | 7056 | | | | 83 | 6889 | | | |
| 81 | 6561 | | | | 45 | 2025 | | | |
| 87 | 7569 | | | | 0 | 0 | | | |
| 78 | 6084 | | | | 0 | 0 | | | |
| 77 | 5929 | | | | 0 | 0 | | | |
| 91 | 8281 | | | | 0 | 0 | | | |
| 82 | 6724 | | | | 0 | 0 | | | |
| 85 | 7225 | | | | 74 | 5476 | | | |
| 82 | 6724 | | | | 0 | 0 | | | |
| 86 | 7396 | | | | 0 | 0 | | | |
| 93 | 8649 | | | | 0 | 0 | | | |
| 88 | 7744 | | | | 0 | 0 | | | |
| 84 | 7056 | | | | | | | | |
| 91 | 8281 | | | | 251 | 16791 | | | |
| 100 | 10000 | | | | Sum | Sum | | | |
| 80 | 6400 | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 81 | 6561 | | | | | | | | |
| 87 | 7569 | | | | | | | | |
| 79 | 6241 | | | | | | | | |
| 92 | 8464 | | | | | | | | |
| 78 | 6084 | | | | | | | | |
| 73 | 5329 | | | | | | | | |
| 81 | 6561 | | | | | | | | |
| 82 | 6724 | | | | | | | | |
| 83 | 6889 | | | | | | | | |
| 80 | 6400 | | | | | | | | |
| 92 | 8464 | | | | | | | | |
| 96 | 9216 | | | | | | | | |
| 0 | 0 | | | | | | | | |
| 91 | 8281 | | | | | | | | |
| | | | | | | | | | |
| 2542 | 216546 | | | | | | | | |
| Sum | Sum | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|-------|--------------------|-----------------------|----------------|----------|
| 477.30 | 8.684 | 42 | 0.05 | 2.021 | Reject |

Appendix 21: Statistical Analysis for Survey Question #12 Comparison

Question 12: My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 1 | 1 | 31 | 1.19 | 0.16 | 2 | 4 | 13 | 1.46 | 0.27 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | 19 | 31 | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 37 | 49 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.19 | -1.850 | 42 | 0.05 | 2.021 | Accept |

Appendix 22: Statistical Analysis for Survey Question #13 Comparison

Question 13: My company plans to seek Energy Star certification on other buildings.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 1.74 | 0.53 | 1 | 1 | 13 | 1.92 | 0.91 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 4 | 16 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | 25 | 59 | | | | | | |
| 3 | 9 | | | | Sum | Sum | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 54 | 110 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.64 | -0.686 | 42 | 0.05 | 2.021 | Accept |

Appendix 23: Statistical Analysis for Survey Question #14 Comparison

Question 14: My company plans to continuously seek ways to improve this building's energy efficiency.

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 1 | 1 | 31 | 1.39 | 0.25 | 1 | 1 | 13 | 1.62 | 0.26 | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 1 | 1 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 1 | 1 | | | | 21 | 37 | | | | | | |
| 2 | 4 | | | | Sum | Sum | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 43 | 67 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.25 | -1.386 | 42 | 0.05 | 2.021 | Accept |

Appendix 24: Statistical Analysis for Survey Question #15 Comparison

Question 15: What is the total size of this building?

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | |
| 2 | 4 | 31 | 3.90 | 2.62 | 3 | 9 | 13 | 3.77 | 4.03 | | | |
| 4 | 16 | | | | 6 | 36 | | | | | | |
| 2 | 4 | | | | 5 | 25 | | | | | | |
| 2 | 4 | | | | 1 | 1 | | | | | | |
| 4 | 16 | | | | 6 | 36 | | | | | | |
| 6 | 36 | | | | 2 | 4 | | | | | | |
| 6 | 36 | | | | 6 | 36 | | | | | | |
| 5 | 25 | | | | 5 | 25 | | | | | | |
| 3 | 9 | | | | 6 | 36 | | | | | | |
| 1 | 1 | | | | 2 | 4 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | |
| 6 | 36 | | | | 4 | 16 | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 3 | 9 | | | | 49 | 233 | | | | | | |
| 4 | 16 | | | | Sum | Sum | | | | | | |
| 2 | 4 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | |
| 5 | 25 | | | | | | | | | | | |
| 6 | 36 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 6 | 36 | | | | | | | | | | | |
| 5 | 25 | | | | | | | | | | | |
| 6 | 36 | | | | | | | | | | | |
| 6 | 36 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 6 | 36 | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | |
| 4 | 16 | | | | | | | | | | | |
| 121 | 551 | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|-------|--------------------|-----------------------|----------------|----------|
| 3.02 | 0.233 | 42 | 0.05 | 2.021 | Accept |

Appendix 25: Statistical Analysis for Survey Question #16 Comparison

Question 16: What year was this building constructed?

Null Hypothesis: There is no difference between mean responses from the Energy Star group and the Comparable buildings group.

| Energy Star building responses | | | | | Comparable building responses | | | | | | | | | | |
|--------------------------------|-----------------------------|----------------|--------------------|-----------------------------|---|-----------------------------|----------------|--------------------|-----------------------------|--|--|--|--|--|--|
| X _E | X _E ² | N _E | X _E bar | S ² _E | X _C | X _C ² | N _C | X _C bar | S ² _C | | | | | | |
| 2 | 4 | 31 | 2.03 | 0.77 | 1 | 1 | 13 | 2.15 | 0.64 | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | | | | |
| 1 | 1 | | | | 3 | 9 | | | | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 3 | 9 | | | | 3 | 9 | | | | | | | | | |
| 2 | 4 | | | | 3 | 9 | | | | | | | | | |
| 3 | 9 | | | | 3 | 9 | | | | | | | | | |
| 3 | 9 | | | | 1 | 1 | | | | | | | | | |
| 3 | 9 | | | | 2 | 4 | | | | | | | | | |
| 2 | 4 | | | | 2 | 4 | | | | | | | | | |
| 3 | 9 | | | | 3 | 9 | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 3 | 9 | | | | 28 | 68 | | | | | | | | | |
| 1 | 1 | | | | Sum | Sum | | | | | | | | | |
| 1 | 1 | | | | E = Energy Star buildings C = Comparable buildings | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 3 | 9 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 2 | 4 | | | | | | | | | | | | | | |
| 1 | 1 | | | | | | | | | | | | | | |
| 63 | 151 | | | | | | | | | | | | | | |
| Sum | Sum | | | | | | | | | | | | | | |

| S^2_p | t | Degrees of Freedom | Level of Significance | Critical Value | Decision |
|---------|--------|--------------------|-----------------------|----------------|----------|
| 0.73 | -0.431 | 42 | 0.05 | 2.021 | Accept |

Appendix 26: Energy Savings Resulting from Energy Star Certification

Question 22: Please provide an estimate of annual energy savings, either in terms of dollars or kWh.

| |
|--|
| 5 - 10 percent. |
| Dollars are the same due to increasing utility costs, but we saw about a 15% decrease in consumption. |
| Over the last 4 years our average savings has been appx. 5.5 KWh per year. |
| Save about 10 to 15,000 kWh annually. |
| 100,000 kWh. |
| 118,656 kwh last 12 month period over prior 12 month period. |
| \$12,000-\$15,000. |
| \$15K - \$30K annually. |
| \$50,000 to \$70,000 annually. |
| ~\$75,000. |
| \$50,000 to \$80,000 annually. |
| 30% reduction in energy costs; about \$300,000 and 25% consumption per year. |
| For this building, can't complete this as the entire bldg was occupied by one tenant who has moved out. |
| We are currently re-tenanting the bldg and of course energy is lower due to lower occupancy. |
| Energy conservations is an ongoing process of better operation, better equipment, and different strategie |
| Since this is constantly evolving with new equipment I can't throw a number at this question. |
| Hard to determine. There are many factors that affect energy consumption in an office building occupancy and weather mostly. |
| Unable to quantify without substantial time invested in researching prior kWh versus current usage. |
| Don't have the records for the initial energy project (lost in hardware failure, but it was significant. |

Appendix 27: Time Spent to Achieve Energy Star Certification

Question 25: If known, what was the estimated number of man-hours spent to achieve Energy Star certification for this building?

| |
|---|
| Minimal |
| 5 |
| 10 |
| 14 |
| 20 |
| 25 - 40 hours. |
| 30-40 hours for gathering and inputing original data. 4-6 hours for engineering certification. 3-4 hours online training. |
| 40 |
| 40 |
| 40 |
| 40+ |
| 50 |
| Strictly guessing 50 hours |
| Approximately 60 hours. |
| 100 hours (estimated) |
| 120- 160 |
| 150 |
| It was a process of evaluating the building, developing a plan, ordering equipment, installing equipment to improve the efficiency of the building (6 months) The remainder was simply entering data on the ES site and monitoring. |
| Unknown - actual time to evaluate system operation and to make changes to maximize potential effectiveness as equipment was designed. |
| Could not begin to explain the hours spent. It is built into our daily operation of managing and maintaining the facility. It all starts with proper commissioning of the building. |

Appendix 28: Costs to Achieve Energy Star Certification

Question 26: If known, what was the estimated total cost to achieve Energy Star certification for this building?

| |
|---|
| No additional cost required. |
| \$0 |
| \$0 |
| \$0 - all done by in house personnel |
| No money involved - system adjustments by inhouse engineering staff. |
| not known, but \$1,500 for the outside engineering firm to certify the information on the building. |
| only cost is the certified engineer all other programs are part of corporate programs |
| Just the cost for professional engineer to certify - don't remember exact cost |
| Ignoring the constant installation of better lighting, HVAC equipment, and DDC. Only money for the PE. |
| Excluding in-house labor. The cost for certified engineer was \$1,250. |
| Approximately \$700.00 |
| \$3,000 |
| \$4,000 |
| \$4,000 |
| \$5,000 approximate cost. |
| \$5,000 |
| \$8,000 (estimated) |
| \$75,000 |
| \$100,000 |
| Approximately \$200,000. |
| Rating was only achieved last year after 10 years of reducing energy consumption with projects such as install a DDC system (\$150k), VFD's on AHU's (\$90k). The only cost incurred during the Energy Star process was for the engineering firm to certify our data and to survey the site at a cost of \$2,500. |
| \$300,000 |
| A lot of man hours |

Appendix 29: Main Reasons for Energy Star Buildings to Recertify

Question 17: Please provide the main reason why you plan to recertify the building through the Energy Star program.

Owner initiative:

| |
|--|
| Owner initiative. |
| Owner request. |
| Company Requirement. Posted for shareholders. |
| Our company has partnered with certain organizations to become more "Green" and this was one big step in doing that. |

Marketing :

| |
|---|
| Marketing. |
| Company-wide, we feel this is important both as a marketing tool and as a way to measure against other buildings in the area. |
| Great Marketing Tool and ownership goal towards more energy efficient methods of operation. |
| It's a socially responsible thing to do. Also looks good in the market place. |
| Recognition for the accomplishments of the building team. |

Helps Achieve LEED certification:

| |
|--|
| LEED certification. |
| It's a requirement of LEED, it's the responsible thing to do, and it makes a strong corporate statement. |

Energy Star Program Delivers Value:

| |
|--|
| There is value in the Energy Star designation. |
| My company considers the program to be very valuable to they way we maintain our facilities. |
| For the social and economic benefits of receiving the Energy Star Label. |

Energy Savings:

| |
|---|
| It validates the energy efficiency operation maintained through management and it is important to the tenant. |
| Tangible demonstration of bldg mgt's believe in energy conservation and controlling utility expenses. |
| It is good to show the tenants and prospects that they are in an energy efficient building. |
| To ensure building operation efficiency and improve leasing opportunities for the future. |
| To ensure we are doing what is necessary to reduce kwh consumption. |
| savings. |

Benchmark Against Other Buildings:

| |
|--|
| For this property, there is no cost to participate in the program and is an inexpensive way to track the building's performance. |
| To provide benchmarking to show progress on energy savings. |
| Recognized by asset manager, commercial real estate management and tenants as one benchmark for a successfully run building. |
| Energy Star provides a benchmark for us to compare our building to others in the area and the country. |
| Energystar is an important tool to measure yourself and your building's performance against the rest of the industry. This information can be used for "green" marketing purposes. Also a continuing effort to reduce energy use helps to offset periodic increases in energy cost. Lower operating expenses and an improved carbon footprint are attractive and powerful marketing tools. |

Tool to Monitor Building Performance:

| |
|---|
| Haven't yet, but will as continued monitoring of the building's performance. |
| A buildings energy consumption can change from year to year. Recertifying the property each year demonstrates our continued drive for excellence in building operation. |
| By following the Energy Star Program, it keeps the level of expectancy and awareness up and current. |

Appendix 30: Statistical Analysis for Energy Star Question #1

Question 1: Even though Energy Star certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.581 | 0.419 | 0.176 | 31 | 0.720 | 0.518 |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 3 | | 1.419 | 2.015 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 4 | | 2.419 | 5.853 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 2 | | 0.419 | 0.176 | | | |
| 1 | | -0.581 | 0.337 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.327 | 1.960 |
| High μ | 1.834 | -1.960 |
| Average μ | 1.581 | 0.000 |

Conclusion: At the .05 level of significance, μ must be between 1.327 and 1.834

Appendix 31: Statistical Analysis for Energy Star Question #2

Question 2: It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.484 | 0.516 | 0.266 | 31 | 0.677 | 0.458 |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 3 | | 1.516 | 2.299 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 3 | | 1.516 | 2.299 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 3 | | 1.516 | 2.299 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |
| 2 | | 0.516 | 0.266 | | | |
| 1 | | -0.484 | 0.234 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.246 | 1.960 |
| High μ | 1.722 | -1.960 |
| Average μ | 1.484 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.246 and 1.722.

Appendix 32: Statistical Analysis for Energy Star Question #3

Question 3: My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 1 | 1.387 | -0.387 | 0.150 | 31 | 0.558 | 0.312 |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 3 | | 1.613 | 2.601 | | | |
| 1 | | -0.387 | 0.150 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.191 | 1.960 |
| High μ | 1.584 | -1.960 |
| Average μ | 1.387 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.191 and 1.584.

Appendix 33: Statistical Analysis for Energy Star Question #4

Question 4: In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 1 | 2.000 | -1.000 | 1.000 | 31 | 0.894 | 0.800 |
| 1 | | -1.000 | 1.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 4 | | 2.000 | 4.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| 4 | | 2.000 | 4.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| 1 | | -1.000 | 1.000 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.685 | 1.960 |
| High μ | 2.315 | -1.960 |
| Average μ | 2.000 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.685 and 2.315.

Appendix 34: Statistical Analysis for Energy Star Question #5

Question 5: My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.613 | 0.387 | 0.150 | 31 | 0.615 | 0.378 |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 3 | | 1.387 | 1.924 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 3 | | 1.387 | 1.924 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.396 | 1.960 |
| High μ | 1.829 | -1.960 |
| Average μ | 1.613 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.396 and 1.829.

Appendix 35: Statistical Analysis for Energy Star Question #6

Question 6: In order to perform the steps to achieve Energy Star certification, this building required other upgrades to bring the building up to the current building code.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.742 | 0.258 | 0.067 | 31 | 0.445 | 0.198 |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.585 | 1.960 |
| High μ | 1.899 | -1.960 |
| Average μ | 1.742 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.585 and 1.899.

Appendix 36: Statistical Analysis for Energy Star Question #7

Question 7: My company's budget was sufficient to accomodate the cost of these upgrades that brought the building up to the current building code.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| | 2.000 | -2.000 | 4.000 | 8 | 3.665 | 13.429 |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |
| 1 | | -1.000 | 1.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |
| 3 | | 1.000 | 1.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| | | -2.000 | 4.000 | | | |
| 2 | | 0.000 | 0.000 | | | |
| | | -2.000 | 4.000 | | | |

| | | |
|-----------------------|--------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | -0.539 | 1.960 |
| High μ | 4.539 | -1.960 |
| Average μ | 2.000 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between -0.539 and 4.539.

Appendix 37: Statistical Analysis for Energy Star Question #8

Question 8: This building currently performs well, and does not need energy-efficient improvements.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 3 | 2.806 | 0.194 | 0.037 | 31 | 1.078 | 1.161 |
| 3 | | 0.194 | 0.037 | | | |
| 1 | | -1.806 | 3.263 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 5 | | 2.194 | 4.812 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 3 | | 0.194 | 0.037 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 3 | | 0.194 | 0.037 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 1 | | -1.806 | 3.263 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 3 | | 0.194 | 0.037 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 3 | | 0.194 | 0.037 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 4 | | 1.194 | 1.425 | | | |
| 3 | | 0.194 | 0.037 | | | |
| 2 | | -0.806 | 0.650 | | | |
| 1 | | -1.806 | 3.263 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 2.427 | 1.960 |
| High μ | 3.186 | -1.960 |
| Average μ | 2.806 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 2.427 and 3.186.

Appendix 38: Statistical Analysis for Energy Star Question #9

Question 9: My company believes a third-party certification is valuable.

[illegible]

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.825 | 1.960 |
| High μ | 2.304 | -1.960 |
| Average μ | 2.065 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.825 and 2.304.

Appendix 39: Statistical Analysis for Energy Star Question #10

Question 10: There are differing opinions among decision makers regarding the value / cost benefits of the Energy Star certification program.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 2.968 | -0.968 | 0.937 | 31 | 1.016 | 1.032 |
| 5 | | 2.032 | 4.130 | | | |
| 4 | | 1.032 | 1.066 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 4 | | 1.032 | 1.066 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 5 | | 2.032 | 4.130 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 5 | | 2.032 | 4.130 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 4 | | 1.032 | 1.066 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 4 | | 1.032 | 1.066 | | | |
| 1 | | -1.968 | 3.872 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 3 | | 0.032 | 0.001 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 2 | | -0.968 | 0.937 | | | |
| 4 | | 1.032 | 1.066 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 2.610 | 1.960 |
| High μ | 3.325 | -1.960 |
| Average μ | 2.968 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 2.610 and 3.325.

Appendix 40: Statistical Analysis for Energy Star Question #11

Question 11: Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 78 | 84.733 | -7 | 45 | 30 | 6.308 | 39.789 |
| 84 | | -1 | 1 | | | |
| 81 | | -4 | 14 | | | |
| 87 | | 2 | 5 | | | |
| 78 | | -7 | 45 | | | |
| 77 | | -8 | 60 | | | |
| 91 | | 6 | 39 | | | |
| 82 | | -3 | 7 | | | |
| 85 | | 0 | 0 | | | |
| 82 | | -3 | 7 | | | |
| 86 | | 1 | 2 | | | |
| 93 | | 8 | 68 | | | |
| 88 | | 3 | 11 | | | |
| 84 | | -1 | 1 | | | |
| 91 | | 6 | 39 | | | |
| 100 | | 15 | 233 | | | |
| 80 | | -5 | 22 | | | |
| 81 | | -4 | 14 | | | |
| 87 | | 2 | 5 | | | |
| 79 | | -6 | 33 | | | |
| 92 | | 7 | 53 | | | |
| 78 | | -7 | 45 | | | |
| 73 | | -12 | 138 | | | |
| 81 | | -4 | 14 | | | |
| 82 | | -3 | 7 | | | |
| 83 | | -2 | 3 | | | |
| 80 | | -5 | 22 | | | |
| 92 | | 7 | 53 | | | |
| 96 | | 11 | 127 | | | |
| 91 | | 6 | 39 | | | |

| | | |
|-----------------------|--------|--------|
| Level of Significance | 0.05 | |
| Critical Val | 1.96 | |
| Low μ | 82.476 | 1.960 |
| High μ | 86.991 | -1.960 |
| Average μ | 84.733 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 82.476 and 86.991.

Appendix 41: Statistical Analysis for Energy Star Question #12

Question 12: My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 1 | 1.194 | -0.194 | 0.037 | 31 | 0.402 | 0.161 |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 1 | | -0.194 | 0.037 | | | |
| 2 | | 0.806 | 0.650 | | | |
| 1 | | -0.194 | 0.037 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.052 | 1.960 |
| High μ | 1.335 | -1.960 |
| Average μ | 1.194 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.052 and 1.335.

Appendix 42: Statistical Analysis for Energy Star Question #13

Question 13: My company plans to seek Energy Star certification on other buildings.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.742 | 0.258 | 0.067 | 31 | 0.729 | 0.531 |
| 1 | | -0.742 | 0.550 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 3 | | 1.258 | 1.583 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 3 | | 1.258 | 1.583 | | | |
| 3 | | 1.258 | 1.583 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 3 | | 1.258 | 1.583 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 1 | | -0.742 | 0.550 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 2 | | 0.258 | 0.067 | | | |
| 3 | | 1.258 | 1.583 | | | |
| 2 | | 0.258 | 0.067 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.485 | 1.960 |
| High μ | 1.999 | -1.960 |
| Average μ | 1.742 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.485 and 1.999.

Appendix 43: Statistical Analysis for Energy Star Question #14

Question 14: My company plans to continuously seek ways to improve this building's energy efficiency.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 1 | 1.387 | -0.387 | 0.150 | 31 | 0.495 | 0.245 |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 1 | | -0.387 | 0.150 | | | |
| 2 | | 0.613 | 0.376 | | | |
| 2 | | 0.613 | 0.376 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.213 | 1.960 |
| High μ | 1.561 | -1.960 |
| Average μ | 1.387 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.213 and 1.561.

Appendix 44: Statistical Analysis for Energy Star Question #15

Question 15: My company plans to continue to track this building's performance through Energy Star's Portfolio Manager software.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.613 | 0.387 | 0.150 | 31 | 0.803 | 0.645 |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 4 | | 2.387 | 5.698 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 1 | | -0.613 | 0.376 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 4 | | 2.387 | 5.698 | | | |
| 2 | | 0.387 | 0.150 | | | |
| 2 | | 0.387 | 0.150 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.330 | 1.960 |
| High μ | 1.896 | -1.960 |
| Average μ | 1.613 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.330 and 1.896.

Appendix 45: Statistical Analysis for Energy Star Question #16

Question 16: Since this building's original Energy Star certification, we have recertified the building on a regular basis, or plan to maintain this building's Energy Star certification in the future by going through the certification process each year.

| <u>X</u> | <u>X bar</u> | <u>X-Xbar</u> | <u>(X-Xbar)²</u> | <u>n</u> | <u>s</u> | <u>s²</u> |
|----------|--------------|---------------|-----------------------------|----------|----------|----------------------|
| 2 | 1.774 | 0.226 | 0.051 | 31 | 0.845 | 0.714 |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 3 | | 1.226 | 1.503 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 3 | | 1.226 | 1.503 | | | |
| 3 | | 1.226 | 1.503 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 3 | | 1.226 | 1.503 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 1 | | -0.774 | 0.599 | | | |
| 2 | | 0.226 | 0.051 | | | |
| 3 | | 1.226 | 1.503 | | | |
| 4 | | 2.226 | 4.954 | | | |
| 1 | | -0.774 | 0.599 | | | |

| | | |
|-----------------------|-------|--------|
| Level of Significance | 0.05 | |
| Critical Value | 1.96 | |
| Low μ | 1.477 | 1.960 |
| High μ | 2.072 | -1.960 |
| Average μ | 1.774 | 0.000 |

Conclusion: At the .05 level of significance with 30 degrees of freedom, μ must be between 1.477 and 2.072.

Appendix 46: Statistical Analysis for Building Age: Question #1

Question 1: Even though Energy Star certification is not required for this building, it is important for buildings to achieve Energy Star certification anyway

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | \bar{X}_T | S_T^2 |
|-------|---------|-------|-------------|---------|
| 1 | 1 | 14 | 1.71 | 0.68 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 50 | | | |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | \bar{X}_T | S_T^2 |
|-------|---------|-------|-------------|---------|
| 1 | 1 | 17 | 1.59 | 0.51 |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 51 | | | |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | \bar{X}_T | S_T^2 |
|-------|---------|-------|-------------|---------|
| 2 | 4 | 13 | 1.92 | 0.74 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 57 | | | |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.71 | -0.643 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.61 | 1.165 | 28 | 0.05 | 2.048 | Accept |

Appendix 47: Statistical Analysis for Building Age: Question #2

Question 2: It is socially responsible to reduce energy consumption and/or the creation of greenhouse gases.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.29 | 0.37 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| Sum | 18 | | | 28 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 1.54 | 0.27 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 20 | | | 34 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.71 | 0.85 |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| Sum | 29 | | | 63 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.32 | -1.154 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.60 | -0.587 | 28 | 0.05 | 2.048 | Accept |

Appendix 48: Statistical Analysis for Building Age: Question #3

Question 3: My company is aware of the steps and costs involved to obtain an Energy Star certification for this building.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.36 | 0.25 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 19 | | | 29 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.35 | 0.24 |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 23 | | | 35 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 13 | 2.31 | 1.40 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 4 | 16 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| Sum | 30 | | | 86 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.80 | -2.760 | 25 | 0.05 | 2.060 | Reject |
| 1990's vs 1980's | 0.74 | 3.017 | 28 | 0.05 | 2.048 | Reject |

Appendix 49: Statistical Analysis for Building Age: Question #4

Question 4: In the past, my company's budget has been sufficient to perform the steps required to obtain the Energy Star certification for this building.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 2.07 | 0.84 |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 29 | | | 71 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 13 | 2.46 | 1.27 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| Sum | 32 | | | 94 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 2.18 | 1.03 |
| 1 | 1 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 37 | | | 97 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 1.05 | -0.990 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 1.13 | 0.727 | 28 | 0.05 | 2.048 | Accept |

Appendix 50: Statistical Analysis for Building Age: Question #5

Question 5: My company believes that there are other financial benefits associated with obtaining an Energy Star certification for a building.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.64 | 0.40 |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 23 | | | 43 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 2.00 | 0.33 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| Sum | 26 | | | 56 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.59 | 0.76 |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| Sum | 27 | | | 55 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.37 | -1.527 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.58 | 1.473 | 28 | 0.05 | 2.048 | Accept |

Appendix 51: Statistical Analysis for Building Age: Question #6

Question 6: In order to perform the steps to achieve Energy Star certification, this building requires other upgrades to bring the building up to the current building code.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 14 | 1.86 | 0.13 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| Sum | 26 | 50 | | |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 17 | 1.53 | 0.26 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| Sum | 26 | 44 | | |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 1.54 | 0.27 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| Sum | 20 | 34 | | |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|--------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.20 | 1.860 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.27 | 0.048 | 28 | 0.05 | 2.048 | Accept |

Appendix 52: Statistical Analysis for Building Age: Question #8

Question 8: This building currently performs well, and does not need energy-efficient improvements.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 2.64 | 1.32 |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| Sum | 37 | | | 115 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 3 | 9 | 13 | 2.85 | 0.64 |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| Sum | 37 | | | 113 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 3 | 9 | 17 | 3.18 | 1.28 |
| 4 | 16 | | | |
| 5 | 25 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| Sum | 54 | | | 192 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 1.00 | -0.529 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 1.01 | -0.894 | 28 | 0.05 | 2.048 | Accept |

Appendix 53: Statistical Analysis for Building Age: Question #9

Question 9: My company believes a third-party certification is valuable.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S_T^2 |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 2.14 | 0.75 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 4 | 16 | | | |
| Sum | 30 | | | |
| | 74 | | | |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S_T^2 |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 2.08 | 0.08 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 27 | | | |
| | 57 | | | |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S_T^2 |
|-------|---------|-------|-------------------|---------|
| 3 | 9 | 17 | 2.18 | 0.90 |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| Sum | 37 | | | |
| | 95 | | | |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.43 | 0.262 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.55 | -0.364 | 28 | 0.05 | 2.048 | Accept |

Appendix 54: Statistical Analysis for Building Age: Question #10

Question 10: There are differing opinions among decision makers regarding the value / cost / benefits of the Energy Star certification program.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 4 | 16 | 14 | 3.14 | 0.75 |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 4 | 16 | | | |
| 4 | 16 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| Sum | 44 | | | 148 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 2.38 | 0.26 |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 31 | | | 77 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 5 | 25 | 17 | 3.00 | 1.38 |
| 3 | 9 | | | |
| 4 | 16 | | | |
| 2 | 4 | | | |
| 5 | 25 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 5 | 25 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| Sum | 51 | | | 175 |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.51 | 2.752 | 25 | 0.05 | 2.060 | Reject |
| 1990's vs 1980's | 0.90 | -1.765 | 28 | 0.05 | 2.048 | Accept |

Appendix 55: Statistical Analysis for Building Age: Question #11

Question 11: Please enter the most recent score obtained through the EPA's Energy Star Portfolio Manager software.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 81 | 6561 | 14 | 76 | 610 |
| 84 | 7056 | | | |
| 100 | 10000 | | | |
| 80 | 6400 | | | |
| 81 | 6561 | | | |
| 87 | 7569 | | | |
| 92 | 8464 | | | |
| 73 | 5329 | | | |
| 83 | 6889 | | | |
| 80 | 6400 | | | |
| 91 | 8281 | | | |
| 49 | 2401 | | | |
| 83 | 6889 | | | |
| 0 | 0 | | | |
| Sum | 1064 | | | 88800 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 78 | 6084 | 13 | 46 | 1994 |
| 87 | 7569 | | | |
| 82 | 6724 | | | |
| 93 | 8649 | | | |
| 81 | 6561 | | | |
| 82 | 6724 | | | |
| 96 | 9216 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| Sum | 599 | | | 51527 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 84 | 7056 | 17 | 66 | 1119 |
| 78 | 6084 | | | |
| 77 | 5929 | | | |
| 91 | 8281 | | | |
| 85 | 7225 | | | |
| 82 | 6724 | | | |
| 86 | 7396 | | | |
| 88 | 7744 | | | |
| 91 | 8281 | | | |
| 79 | 6241 | | | |
| 78 | 6084 | | | |
| 92 | 8464 | | | |
| 45 | 2025 | | | |
| 0 | 0 | | | |
| 0 | 0 | | | |
| 74 | 5476 | | | |
| 0 | 0 | | | |
| Sum | 1130 | | | 93010 |

| | S^2_p | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 1275 | 2.176 | 25 | 0.05 | 2.060 | Reject |
| 1990's vs 1980's | 1494 | -1.432 | 28 | 0.05 | 2.048 | Accept |

Appendix 56: Statistical Analysis for Building Age: Question #12

Question 12: My company plans to pursue the USGBC's LEED (Existing Buildings Operations and Maintenance) certification for this building.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.21 | 0.18 |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| Sum | 23 | | | |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.24 | 0.19 |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| Sum | 29 | | | |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 13 | 1.38 | 0.26 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| Sum | 28 | | | |

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.22 | -0.949 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.22 | 0.866 | 28 | 0.05 | 2.048 | Accept |

Appendix 57: Statistical Analysis for Building Age: Question #13

Question 13: My company plans to seek Energy Star certification on other buildings.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.50 | 0.42 |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 21 | | | |
| | 37 | | | |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.76 | 0.82 |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| Sum | 30 | | | |
| | 66 | | | |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 2 | 4 | 13 | 2.15 | 0.47 |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 3 | 9 | | | |
| 3 | 9 | | | |
| 1 | 1 | | | |
| 3 | 9 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 28 | | | |
| | 66 | | | |

Sum

| | $S^2 p$ | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|--------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.45 | -2.537 | 25 | 0.05 | 2.060 | Reject |
| 1990's vs 1980's | 0.67 | 1.291 | 28 | 0.05 | 2.048 | Accept |

Appendix 58: Statistical Analysis for Building Age: Question #14

Question 14: My company plans to continuously seek ways to improve this building's energy efficiency.

Null Hypothesis: There is no difference between mean responses from the two groups studied.

Total Building Responses

Group A: Built Between 2000 - 2008

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 14 | 1.43 | 0.26 |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 20 | | | 32 |

Group C: Built Between 1980 - 1989

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 17 | 1.47 | 0.26 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| Sum | 25 | | | 41 |

Group B: Built Between 1990 - 1999

| X_T | X_T^2 | N_T | $X_T \text{ bar}$ | S^2_T |
|-------|---------|-------|-------------------|---------|
| 1 | 1 | 13 | 1.46 | 0.27 |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 1 | 1 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| 2 | 4 | | | |
| Sum | 19 | | | 31 |

| | S^2_p | t | Degrees of Freedom | Level of significance | Critical Value | Decision |
|------------------|---------|---------------|--------------------|-----------------------|----------------|----------|
| 2000's vs 1990's | 0.27 | -0.166 | 25 | 0.05 | 2.060 | Accept |
| 1990's vs 1980's | 0.27 | -0.048 | 28 | 0.05 | 2.048 | Accept |

Appendix 59

Model Statutory Language for States or Localities to Require Building Benchmarking

Source: Institute for Market Transformation



IMT Model Statutory Language for States or Localities to Require Building Benchmarking

Suggested Statutory Language: *(a) On and after January 1, 20XX, electric and gas utilities shall maintain records of the energy consumption data of all nonresidential buildings to which they provide service. This data shall be maintained, in a format compatible for uploading to the United States Environmental Protection Agency's (EPA's) ENERGY STAR Portfolio Manager, for at least the most recent 36 months.*

(b) On and after January 1, 20XX, upon the written authorization or secure electronic authorization of a nonresidential building owner or operator, an electric or gas utility shall upload all of the energy consumption data for the account specified for a building to The EPA's ENERGY STAR Portfolio Manager in a manner that preserves the confidentiality of the customer.

(c) In carrying out the requirements of this section, an electric or gas utility may use any method for providing the specified data in order to maximize efficiency and minimize overall program cost, and is encouraged to work with EPA and customers in developing reasonable reporting options.

(d) On and after January 1, 20XX, an owner or operator of a nonresidential building over 10,000 square feet shall disclose the EPA's ENERGY STAR Portfolio Manager benchmarking data and ratings for the most recent 24-month period to a prospective buyer, lessee of over 2,000 square feet of the building, or lender that would finance over 2,000 square feet of the building. On and after January 1, 20XX, an owner or operator of a nonresidential building over 10,000 square feet shall annually disclose the EPA's ENERGY STAR Portfolio Manager benchmarking data and ratings for the most recent 24-month period to lessees of the building. If the data is delivered to a prospective buyer, lessee, or lender, then a property owner, operator, or their agent is not required to provide additional information, and the information shall be deemed to be adequate to inform the prospective buyer, lessee or lender regarding EPA's ENERGY STAR Portfolio Manager benchmarking data and ratings for the most recent 24-month period for the building that is being sold, leased, financed, or refinanced.

(e) Notwithstanding subdivision (d), nothing in this section increases or decreases the duties, if any, of a property owner, operator, or his or her broker or agent under this chapter or alters the duty of a seller, agent, or broker to disclose the existence of a material fact affecting the real property.

(f) Beginning one year after the effective date of this Act all nonresidential buildings over 10,000 square feet owned or operated by the _____ government or any of its instrumentalities shall be publicly benchmarked annually using the Energy Star Portfolio Manager benchmarking tool.

(g) All privately-owned nonresidential buildings shall be benchmarked annually using the Energy Star Portfolio Manager benchmarking tool as designated by the schedule in paragraph (h) of this subsection; benchmarking data and ratings for the most recent 24-month period each building shall, by January 1 of the following year, be made available to [government agency]. [Government agency] shall, upon the receipt of the 2nd annual benchmarking data for each building, make the data accessible to the public via an online database.

(h) The schedule shall be as follows:

(A) All buildings over 150,000 square feet of gross floor area beginning in 2011 and thereafter;

(B) All buildings over 50,000 square feet of gross floor area beginning in 2012 and thereafter.

(i) A project that has submitted the 1st building construction permit after January 1, 2011, for new construction or substantial improvement shall, prior to construction, estimate its energy performance using the Energy Star Target Finder Tool and shall subsequently be benchmarked annually using the Energy Star Portfolio Manager benchmarking tool; provided, that the building is over 10,000 square feet. Benchmark and Target Finder ratings and data for each building shall, within 60 days of being generated, be made available to [government agency], which shall make the data accessible to the public via an online database.

(j) [Government agency] shall be the implementing agency for this Act and shall issue implementing rules within 90 days after the effective date of this Act.

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